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DEVELOPMENT OF A CURRICULUM AND MATERIALS FOR TEACHING BASIC VOCATIONAL TALENTS. FINAL REPORT.

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DESCRIPTORS- *INSTRUCTIONAL MATERIALS, *CULTURALLY DISADVANTAGED, GRADE 8, GRADE 9, *EXPERIMENTAL CURRICULUM, *VOCATIONAL APTITUDE, SKILL DEVELOPMENT, BASIC SKILLS, *PREVOCATIONAL EDUCATION, MATERIAL DEVELOPMENT, APTITUDE TESTS,

THE OBJECTIVES OF THIS PROJECT WERE TO DEVELOP AND EVALUATE SPECIAL INSTRUCTIONAL MATERIALS COVERING ABSTRACT REASONING, MECHANICAL COMPREHENSION, AND SPATIAL VISUALIZATION AS RELATED TO BASIC VOCATIONAL TALENTS FOR EIGHTH AND NINTH GRADE STUDENTS WHO HAD A HIGH PROBABILITY OF ENTERING VOCATIONAL EDUCATION. THE MATERIALS, PAPER AND PENCIL APTITUDE PRACTICE EXERCISES, BASIC READING TEXTS, AND LABORATORY AND DEMONSTRATION EQUIPMENT, WERE USED IN 30 CLASS SESSIONS FOR THE EIGHTH GRADE AND 60 CLASS SESSIONS FOR THE NINTH GRADE IN SCHOOLS IN EIGHT SYSTEMS SELECTED FROM A NATIONAL POPULATION. RESULTS WERE BASED ON TEST-RETEST CHANGES ON A BATTERY OF TESTS FROM PROJECT TALENT FOR 1,203 BOYS AND 262 GIRLS FOR WHOM COMPLETE DATA WERE AVAILABLE. CONCLUSIONS BASED ON STATISTICAL ANALYSIS OF DATA INCLUDED (1) BASIC VOCATIONAL TALENTS CAN BE TAUGHT DIRECTLY IN SCHOOLS USING THE NEW CURRICULUM AND MATERIALS, (2) NO "GENERAL TEST TAKING SKILL" WAS FOUND, (3) GIRLS TENDED TO GAIN MORE ON TESTS THAN BOYS, (4) NINTH GRADERS WHO USED THE LABORATORY MATERIALS SHOWED MORE GAIN THAN EIGHTH GRADERS WHO DID NOT, (5) NONVERBAL TEST SKILLS SEEMED TO BE AS EASILY MODIFIABLE AS WERE VERBAL TEST SKILLS, (6) MECHANICAL TALENT OR APTITUDE APPEARS TO BE A SKILL LARGELY LEARNED THROUGH A VARIETY OF OUT-OF-SCHOOL EXPERIENCES, AND (6) CULTURALLY DISADVANTAGED STUDENTS CAN BE TRAINED TO DO SUBSTANTIALLY BETTER ON VOCATIONAL APTITUDE TESTS. DESCRIPTIONS OF THE TALENT EXERCISES, BASIC READERS, LABORATORY EXERCISES, AND THE TEST BATTERY ARE INCLUDED. THESE ARE AVAILABLE AS VT 004 455 THROUGH VT 004 471. (EM)

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Development of a Curriculum and Materials for Teaching Basic Vocational Talents

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and
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The George Washington University
Educational Research Project

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DEVELOPMENT OF A CURRICULUM AND MATERIALS FOR TEACHING BASIC VOCATIONAL TALENTS .

John T. Dailey
and
Clinton A. Neyman, Jr.

Final Report
for
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SUMMARY OF PROJECT

Contract No.	OE-5-85-023
Title	Development of a Curriculum and Materials for Teaching Basic Vocational Talents
Investigator	Dr. John T. Dailey
Institution	The George Washington University
Duration	1 March 1965 to 30 December 1966

Purpose

There is a growing need for vocationally and technically trained youth at high skill levels to meet the expanding demands of both industry and the military services for technically trained personnel. Vocational and technical schools and the Armed Forces find that they must educate many marginally trainable youth -- that is, young people who are trainable in some useful occupational skills but are not readily trainable for the more highly skilled jobs with a good future. These marginally trainable youth lack basic educational skills as well as basic understanding of mechanical and technical concepts and principles and other knowledge needed to take full advantage of opportunities for vocational and technical education either in school or on the job.

If our culturally deprived adolescents are to have a full chance to emerge from poverty there must be a massive upgrading in the levels of their developed basic skills that we often call talents. Various studies of Project Talent data have indicated that many of our youth from culturally deprived backgrounds leave school lacking the basic skills and aptitudes or talents necessary for training for many of our more highly skilled jobs. Of course, such tests as those in Project Talent do not identify latent talents that a student's environment has not permitted to develop; they measure the skills that he has developed but not the skills he might have developed in a more favorable environment. Nevertheless, the important tests in Project Talent do define the skills that must be developed in our culturally deprived adolescents if they are to be able to compete on equal terms in our society with those from more fortunate environments.

In order to help every individual reach his full potential, new and better ways of assessing and developing the potential of individuals from minority or culturally deprived groups are needed. New materials and methods are needed to identify and develop these latent talents.

The objective of this research was to develop and evaluate special new training materials to teach basic vocational talent skills in the areas of abstract reasoning, mechanical comprehension, and spatial visualization to 8th- and 9th-grade students who have a high probability of entering vocational training.

Answers to the following questions were sought: How much is it possible to raise the level of vocational talent by the use of these materials? Does improved test performance from direct training in abstract reasoning and mechanical comprehension materials generalize to other important basic mental aptitudes? To what extent does the increase in test performance persist?

Procedure

Three different types of materials were developed for this project, as follows:

1. A series of paper-and-pencil basic aptitude practice exercises designed to teach nonverbal abstract reasoning, basic mechanics, basic electricity, and both two- and three-dimension spatial reasoning. These materials are very similar to test items in format and are designed for use in training both adolescents and young adults. They were used in 30 class periods, one period per week, in grades 8 and 9.

2. A series of basic readers especially designed for vocationally oriented and culturally disadvantaged students in grades 8 and 9 who read at two or three grade levels below their placement. These readers provide materials at a low-difficulty high-maturity level, and cover various aspects of tools, machines, mechanical and electrical principles, and occupations. They were used in conjunction with the basic aptitude practice exercises but were worked into regular class activities without extra scheduled time. The titles of the readers are:

"Transportation Long Ago"
"Transportation Today and Tomorrow"
"The Automobile"
"Occupations for You"
"Tools and Basic Machines"

3. Laboratory equipment and simple demonstration devices designed to teach 9th-grade students those aspects of mechanical ability and basic mechanical and technical comprehension and understanding that are not suitable for teaching either by paper-and-pencil exercises or by readers. The equipment was used in conjunction with the basic aptitude practice exercises in grades 9 and 10. The laboratory equipment demonstrated principles of devices such as: gear trains, levers, belts and pulleys, inclined plane and screw threads, friction, magnetism, and simple electrical circuits. Student's and teacher's manuals were developed. One class period per week was scheduled.

The materials developed were tried out in a representative sample of approximately 2,500 boys and girls in eight school systems located in San Antonio, Texas; Atlanta, Georgia; Wise County, Virginia; Washington, D.C.; New York City; Bayonne, New Jersey; Erie, Pennsylvania; and Detroit, Michigan.

The primary method of evaluation was the comparison of pre-test and post-test scores of the students. Factor analysis studies were also made of both pre-test and post-test results. Gains were also compared with the findings of Project Talent in both its cross-sectional study and longitudinal study of the American high school student.

Key tests from the Project Talent Test Battery were used for the pre-test and post-test measures of learning both in the subject-matter areas of the curriculum and in other unrelated areas. These tests were: Abstract Reasoning, Mechanical Reasoning, Arithmetic Reasoning, Visualization in Two Dimensions, Visualization in Three Dimensions, Reading Comprehension, Vocabulary Information, Mathematics Information, Physical Sciences Information, Biological Sciences Information, Aeronautics and Space Information, Electricity and Electronics Information, and Mechanics Information.

Results and Conclusions

This study has demonstrated that important aptitude test skills or vocational talents can be taught to a significant degree with relatively simple materials and procedures within typical public school systems. This has many important implications for the theory of measurement as well as for the general fields of compensatory education and special training for the culturally deprived.

The following conclusions and recommendations seem warranted on the basis of the study:

1. Important vocational talents can be taught directly in schools or in other training programs using the new curriculum and materials developed for this purpose in this project. These talents include mechanical reasoning, mechanical information, nonverbal abstract reasoning, spatial visualization, physical sciences information, and electrical and electronics information. The increase in level of talent should help the students to learn the specific skills and understandings taught in vocational high schools or other training programs.

2. No "general test-taking skill" was found. Training on one sort of skill did not affect test performance on different skills not taught. Training in mechanics, for instance, did not help in taking arithmetic or reading tests.

3. As compared with their usual annual gain on tests of basic vocational talents, girls tended to gain more than did the boys. If girls have equal exposure to learning opportunities in technological areas they seem to be able to develop basic vocational talents as well as do the boys. The use of the new curriculum with girls could do much to minimize sex differences in basic technological skills. This could be an important factor in encouraging more girls to enter careers in engineering or the physical sciences.

4. On the tests related to the content of the laboratory course the 9th-grade students who had the training showed more gain than did the 8th-grade students who did not.

5. The materials were also used successfully in training programs for 8th-grade boys who were underachievers, several groups of poor readers in grades 7 to 12, young adults who had failed the test for enlisting for military duty, and young felons and delinquents.

6. Mechanical talent or aptitude appears to be a skill largely learned through a variety of out-of-school experiences. A rural or small-town environment is particularly rich in such experiences, and mechanical comprehension has been well named "barnyard physics." This study has demonstrated that our schools and other training programs can compensate for the lack of environmental stimulation in mechanics and technology that handicaps most of our young people today.

7. Nonverbal test skills seem to be as easily modifiable by training as are verbal test skills. It seems likely that most nonverbal skills are as much influenced by past opportunities for learning them as are verbal skills.

8. Talent training can cause changes in the basic intercorrelational characteristics of tests and in their factorial structure. The amount of change appears to be greatest for those groups with least previous opportunity to learn the skills sampled by the tests. For tests of technological talent, such groups include girls and many groups of boys in especially culturally disadvantaged urban areas.

9. Culturally disadvantaged students can be trained to do substantially better on important tests of vocational aptitudes or talents. This could qualify appreciably greater numbers of young people for military, governmental, or industrial training programs where selection is based on aptitude tests.

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VOCATIONAL TALENT EXERCISES

Clinton A. Neyman, Jr., Raymond H. Fernandez, George T. Hilliker, and James N. Jordan, assisted by Dr. Louis R. Decker, Ricardo Nieto, Elizabeth R. Moore, and Theodora V. Bromley.

BASIC READERS

"Transportation Long Ago" -- Dr. John T. Dailey and Bernard Blumberg.

"The Automobile" -- Dr. John T. Dailey, Clinton A. Neyman, Jr., and Louis S. Kasiaras, with assistance from James R. Hill and William F. James.

"Tools and Basic Machines" -- Clinton A. Neyman, Jr., and Grace C. Alexander, assisted by Herbert K. Dover.

"Transportation Today and Tomorrow" -- Grace C. Alexander and Clinton A. Neyman, Jr., assisted by Ruth S. Ferriss.

"Occupations for You - Part One" and "Occupations for You - Part Two" -- Dr. John T. Dailey, Dean L. Des Roches, and Ann M. Riordan, assisted by Jane Schroeder, Raymond H. Fernandez, and Louise O. Umstott.

LABORATORY TRAINING COURSE

Designed and developed by Dr. John T. Dailey, Clinton A. Neyman, Jr., James R. Hill, and Dr. William B. Evans, Jr.; and after tryouts, revised and reengineered by George T. Hilliker and James N. Jordan. Raymond H. Fernandez assisted in both the original development and revision. The mechanical and electrical equipment was constructed by EduTech and the electronics equipment by Science Electronics.

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Chapter 1

INTRODUCTION

I. PROBLEM

Vocational educators today must solve two very serious problems, which are ever increasing in importance. First, there is the growing competition with colleges for upper ability high school graduates as more and more young men and women seek college degrees. Second, there is a growing demand for vocationally trained youth to meet the expanding needs of both industry and military services.

As a result, vocational schools find that they must educate an increasing number of marginally trainable youth; that is, young people who are trainable for useful occupations but not for the more highly skilled jobs with a good future. These marginally trainable youth lack not only basic educational skills but the understanding of basic mechanical and technical principles needed to take full advantage of vocational education. Anything that can be done to increase the number of young people who are capable of being trained for more highly skilled jobs would be a major contribution toward reducing the number of unemployed or underemployed in our society.

The overall problem of how to increase the number of trainable youth is so complicated that every and any method should be tried in an effort to solve it. Many approaches have been tried in the last few years: programed learning, television, curriculum revision, job simplification, and improved testing and counseling, to name but a few. All of these may help, but what is really needed is some means of increasing the ability of marginal students to learn the skills required for success in vocational and technical training.

II. OBJECTIVES

This project sought to increase the trainability of 8th- and 9th-grade students before they go into specialized occupational training in the 10th grade and above. This was done through the development and use of training materials designed to teach the basic vocational talent skills of abstract reasoning, mechanical comprehension, and spatial visualization to students with a high probability of entering vocational training. The subject matter consisted of instructional material of three types:

First: a series of paper-and-pencil practice exercises in the areas of nonverbal abstract reasoning, basic mechanics, basic electricity, basic science, and spatial visualization.

Second: a series of basic readers profusely illustrated and expository in style, to cover information in mechanical fields.

Third: a kit of special devices and equipment to demonstrate and explain basic scientific, mechanical, and electrical principles and phenomena.

All three of these materials are described in more detail in Chapter 3 and Appendix B.

The primary method of determining achievement in these fields was through testing in the subject-matter areas before and after the instructional material was used.

III. RESULTS DESIRED

In addition to demonstrating that it is possible to teach these basic skills in the classroom, it was hoped that at the end of the project we would have developed a completely new set of instructional materials that would give a good general preparation for later specialization and training in vocational and technical courses.

IV. RELATED RESEARCH AND BACKGROUND INFORMATION

Aptitude tests are almost universally used as screening devices for admission to vocational and technical education courses and schools. The people who fail to qualify for entry into these schools are those who probably most need this type of training. Therefore, one way of helping culturally and economically underprivileged youth to emerge from poverty and to hold a job with a future is to raise their aptitude levels to enable them to qualify for these schools.

Since the earliest days of aptitude testing, test psychologists have been on the defensive against those who charge that tests are meaningless, and at the same time they have been debunking occasional claims of miraculous improvements in IQ or other test performance. They have been on the defensive in proving that the effects of short periods of coaching for aptitude tests have been slight and not great enough to invalidate the tests in common use.

Nevertheless, it has always been apparent that students learn by being tested -- even by being tested only once. Anyone who has ever done a test-retest study knows that almost any group does better the second time on a test, even on a different form and with no feedback of results.

There is much evidence that students seem to learn and retain only a very little from a single school period, and that only very slight differences in learning are often associated with fairly large variations in the amount of effort expended. It is quite possible that students may learn as much while taking tests as they do during most other activities in the classroom in a comparable amount of time. Many studies have found that a great deal of the variation in how much students learn is a function of their levels of aptitudes related to the learning programs (Flanagan et al., 1962; Dailey, 1965; Dailey, 1966).

Dr. Thelma Thurstone (1958, 1963), in research at the Psychometric Laboratory at the University of North Carolina and earlier at the University of Chicago, has shown that it is possible to obtain promising results in improving the basic mental skills of preschool disadvantaged children by giving them practice on tasks that appear as items in reading readiness tests. In addition, she has obtained significant improvement in reading comprehension at all levels of primary and secondary school students by giving them practice with reading comprehension test items. In carrying out her research she developed over four thousand reading comprehension items carefully scaled over all levels. She also has developed placement tests which help establish the reading level most appropriate for each student. Nearly twice the normally expected rate of gain has been found in a number of studies at grades three to twelve. Successful results were also found for a group of university students who were average or good readers and wanted to become still better readers.

Professor B. Stevanovic (1964), the University of Belgrade, at the XV International Congress of Applied Psychology, at Ljubljana, Yugoslavia (6 August 1964), summarized the literature on the educability of abilities, and concluded that human abilities definitely were educable to a significant degree at both high and low levels of ability and for both general and special abilities.

Another very strong indication as to the nature of the problem was demonstrated in Project Talent (Flanagan et al., 1962) where it was found that when schools are grouped homogeneously those schools where performance is poor on such tests as Reading Comprehension and Information also show poor performance on Abstract Reasoning. The relationship between these tests is such as to indicate that the ability to perform on tests of abstract reasoning acts as a ceiling on performance on the other types of tests such as Reading Comprehension and Information.

One of the main reasons why people who score poorly on tests do poorly in the corresponding training situations may be because of lack of understanding of basic educational and mechanical skills requisite to success in such training. Anything which might raise these skills would be a very important educational tool. Raising the abilities of this poor-scoring group even 5 or 10 percentile points would be a distinct gain in greater usability of manpower.

V. METHODS OF ANALYSIS

The primary method of analyzing the results of instruction was to compare pre-test and post-test scores in the areas taught by the curriculum materials with the pre-test and post-test scores in the areas not taught by the curriculum materials. The extent to which the aptitude training changes the patterning of aptitude scores was also investigated. Factor analysis was used to estimate the changes that result from this training. In addition, the results were also compared with aptitude growth data from groups in Project Talent.

It was expected that some groups of students would respond to practice better than others. The characteristics of these students and groups were studied where possible, with particular reference to school, home, and neighborhood factors, as well as aptitude, interest, and motivation.

Statistical results are given in Chapter 4 and in Appendix A of this report.

Chapter 2

PROCEDURE

I. INTRODUCTION

Since the contract for the study was given its final approval very shortly before the beginning of the school year, it was necessary to proceed with several phases of the study simultaneously. This meant some overlap in the hiring and training of project personnel; preparation of the basic test battery; preparation of the curriculum booklets and instructions; the designing, manufacture, and shipping of the various materials; and plans for the evaluation of the project. However, it was possible to compress the time period for the study, and most of the materials planned for development were ready in time for tryout by the schools.

This chapter describes how the sample was obtained, the characteristics of the sample, how the pre-instruction and post-instruction testing was done, the nature of the test instruments, and how the new curriculum materials were used.

Staff members of the project made several visits to each school, to deliver the materials and explain their use, as well as to discuss the overall project with the school staff. The curriculum materials were designed to be self-explanatory and required no special training or instruction for the teachers. The materials were used in regular courses of the school by the regular teachers. Reports from the teachers and administrators were that the students responded very well to the materials and that, while there were some occasional problems with their use, they were solved without any additional assistance. The Project Talent pre-tests and post-tests were administered by the regular school staff.

II. SELECTION OF THE SAMPLE

The names of the school systems taking part in this project were selected to be representative of a list obtained from Mr. W. M. Arnold, Assistant Commissioner for Vocational and Technical Education, of the Office of Education of the Department of Health, Education, and Welfare.

The foreword to this list said, "The public vocational schools in this list were selected from the *U.S. Office of Education Directory of Preparatory Trade and Industrial Training Programs*. Only schools designated as vocational, technical, industrial, or trade serving primarily as high schools are included. Specifically excluded were: (1) vocational schools in New York City, (2) vocational schools teaching less than six trades or deemed to have less than 50 seniors, and (3) schools of practical nursing only." The total list contained the names of 150 schools and may be regarded as the universe of schools having substantial vocational education programs in 1963, outside of New York City.

The special curriculum materials were tried out in the junior high schools feeding into the vocational high schools on the list. This arrangement was made to facilitate later follow-up into vocational training.

Table 2-1 shows the schools in the sample with the number of students by grade and sex in each school system.

Table 2-1 Distribution of Students in Sample by School System, Grade, and Sex

School System	Grade 8			Grade 9*			TOTAL		
School Name	M	F	Total	M	F	Total	M	F	Total
Atlanta, Georgia	62	31	93	63	71	134	125	102	227
Carver Vocational HS									
Erie, Pennsylvania	171		171	155		155	326		326
Technical Memorial HS Memorial JHS									
San Antonio, Texas	137	7	144	95	29	124	232	36	268
Irving JHS Rhodes JHS									
Wise County, Virginia	121	57	178	77	80	157	198	137	335
Appalachia HS Coeburn HS J. J. Kelly HS Pound HS Powell Valley HS									
Washington, D.C.	177	99	276	138	75	213	315	179	489
Douglass JHS Hart JHS									
Bayonne, New Jersey	280		280	328		328	608		608
Bayonne HS 12 Bayonne Elementary									
Detroit, Michigan				83*		83*	83		83
Kettering HS									
New York, New York	49	50	99				49	50	99
John Roberts JHS									
TOTALS	997	244	1241	939	255	1194	1936	504	2435

* The Detroit sample, which consisted of 10th- and 11th-grade boys, used the same curriculum as the regular 9th-grade sample.

Description of School Systems in Sample

Atlanta, Georgia - Carver Vocational High School: This is a five-year comprehensive vocational school with grades 8 through 12. The 8th and 9th grades are preparatory to vocational specialization in grades 10, 11, and 12. This school draws from a low socioeconomic level population.

Erie, Pennsylvania - Technical Memorial High School and Rhodes Junior High School: These two schools, although they occupy the same building, are completely independent. The population of Erie is primarily industrial, and the students come from middle-class homes with both blue-collar and white-collar parents.

San Antonio, Texas - Irving Junior High School and Rhodes Junior High School: These are schools serving a low socioeconomic population and have many Spanish-American students.

Wise County, Virginia - Appalachia High School, Coeburn High School, J. J. Kelly High School, Pound High School, and Powell Valley High School: All five of these high schools are 7-12 grade schools. These schools are in the Appalachian region of Virginia where the primary occupation is coal mining. While the general economic level of the region is low, the aptitudes seem high.

Washington, D.C. - Douglass Junior High School and Hart Junior High School: These regular three-year schools are not in the center city of Washington, but nevertheless draw from moderately low-socioeconomic-status families.

Bayonne, New Jersey - Twelve elementary schools and Bayonne High School participated in the study. Their system is KI-8, 9-12. The 9th-grade boys chosen for this project were those who were in the vocational courses in the high school.

New York City - John Roberts Junior High School: Three 8th-grade classes participated in the project. This school is in Harlem, and many of the students were native Spanish-speaking.

Detroit, Michigan - Kettering High School: This is a three-year school for 10th, 11th, and 12th grades. It is a new school and is strong in the vocational fields. The three classes that participated were 10th grades with a few 11th-grade students in them.

III. ADDITIONAL EXPERIMENTAL GROUPS

During the course of the project, several other groups expressed strong interest in the possible use of the materials and so additional collateral demonstrations on a small-scale basis were made. These included the following:

1. The North Carolina Advancement School, Winston-Salem, North Carolina: This was a residential school for 8th-grade boys of normal intelligence but who were underachieving in school. Some of the materials were tried out informally in math classes and in English classes there.

2. The National Committee for Children and Youth, Washington, D.C.: N.C.C.Y. was conducting a program to train young men who had been rejected by the Armed Forces because they failed the volunteer selection test, in order to help these men to pass the AFQT or to get a job. Our materials were used as part of this program. After completing the training course most of the graduates took the AFQT again and a high proportion of them passed it. More details are given in Appendix C of this report.

3. Project Challenge, the National Committee for Children and Youth (N.C.C.Y.), District of Columbia Youth Center, Lorton, Virginia: This is a rehabilitation and educational center for serious offenders from the age of 18 to 25 for the District of Columbia. The materials were used together with a formal test and retest. More details and results are given in Appendix C.

4. San Rafael, California, Public Schools: Here the readers were used experimentally with groups of 8th-grade poor readers who were using an apparatus where they read materials as the materials were read to them. The reports were that the students were very highly motivated by the mechanical and technological content of the readers and that the materials were very appropriate for this sort of use.

5. Future for Jimmy, Urban League and the Public Schools, Washington, D.C: This is a tutorial program where volunteers tutor junior high school students. Booklet A of the Vocational Talent Exercises was used by the tutors, who reported that the students were highly motivated and stimulated by this and that these booklets were very suitable for use in tutorial programs at this level.

6. Cardozo High School, Grade 12, Washington, D.C.,Public Schools: Here some of the readers were used in a special English class for poor achievers, and the reports were that they were useful for this purpose. Most of the students were reading in the 3rd- to the 6th-grade level.

7. Shaw Junior High School, D.C. Public Schools, Grade 7: Here the use of some of the readers was demonstrated by project staff to a group of 7th-grade boys who were very poor readers and had been very poorly motivated for reading. The demonstration was observed by 25 D.C. public school teachers and representatives from the public schools in Puerto Rico. The boys responded very well to the reading materials and displayed a strong degree of interest in them. Some of their teachers said boys were showing interest in written materials who had never done so before. Apparently the readers were quite suitable for use with this group who, for the most part, was reading below the 5th-grade level.

8. Boulder County Juvenile Court Demonstration Project, Boulder, Colorado: Here the materials are being used informally and have been found to be very suitable for use with young institutionalized delinquents.

IV. THE VOCATIONAL TALENT TEST BATTERY

Test instruments were used for determining gain in learning as a result of the use of curriculum materials in the fields of abstract reasoning, mechanical comprehension, spatial visualization, and technical information. It was determined that the tests used by Project Talent in the 1960 census of aptitudes and abilities would be the most appropriate. Several other Project Talent tests were given for control purposes. The tests used were as follows:

Name of Test	Project Talent Ident. No.	Number of Items	Time (minutes)
Abstract Reasoning	R-290	15	11
Mechanical Reasoning	R-270	20	11
Arithmetic Reasoning	R-311	16	12
Visualization in Two Dimensions	R-281	24	4
Visualization in Three Dimensions	R-282	16	9
Reading Comprehension	R-250	48	30
Information Test --			45
Vocabulary Scale	R-102	22	
Mathematics Scale	R-106	23	
Physical Sciences Scale	R-107	18	
Biological Sciences Scale	R-108	11	
Aeronautics and Space Scale	R-110	10	
Electricity and Electronics Scale	R-111	20	
Mechanics Scale	R-112	19	
Interest Inventory	R-700*	150	15

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* Modified form with several scales removed. Only complete scales were included.

After the basic test instruments had been selected from the Project Talent battery the following materials were prepared:

A. Test Booklet for Vocational Education Test Battery

This contained the preliminary instructions for the student plus the various tests and modified interest inventory.

B. Test Administrator's Manual

This manual contained the instructions to the test administrator for the testing session. It also contained tables for converting raw scores to percentile ranks. These percentile ranks were based on the Project Talent report, "Studies of a Complete Age Group -- Age 15" (Shaycoft, 1963). The 15-year-old norms were used for this study because it was felt that they were more appropriate for the kinds of students in this project since they were based on all 15-year-old students whether in school or not. Norms are available in other Project Talent reports for grades 9, 10, 11, and 12.

C. Student Information Blank

Part I of this instrument was based upon the Project Talent Student Information Blank, modified to include details thought important to the evaluation of pre-vocational students.

Part II consisted of a questionnaire designed to obtain information about attitudes toward 38 important vocational courses. These were arranged in alphabetical order, and included vocational courses suitable for girls as well as boys.

V. ADMINISTRATION OF THE TEST BATTERY

The basic test battery was administered to the students in all school systems prior to the beginning of instruction. It was also given again at the end of the instruction period. Approximately four class periods were required to administer the battery. All of the items in the test battery were re-administered at the end of the instruction period except for the background items in the Student Information Blank. Only the preference items in Part II of the Student Information Blank were given at the second administration and Part II was printed as a separate page.

Chapter 3

DEVELOPMENT AND USE OF CURRICULUM MATERIALS

I. INTRODUCTION

The target population for this research was students in the 8th and 9th grades who read at two or three grade levels lower than their grade placement. Curriculum materials were written in such a manner as to minimize reading difficulty. This was accomplished by using simple vocabulary, writing the materials double-spaced, using wide margins, and with as many pictures as possible. In many instances the paragraphs were staggered in order to break up the straight left margin. Paragraphs were also separated where possible by an extra blank space. See Appendix B for details on content.

Copies of all published materials are included as attachments to this report.

Three types of materials were prepared for this project: basic aptitude training exercises, laboratory exercises, and readers. Each of these three types of materials is described in detail below.

II. BASIC APTITUDE TRAINING EXERCISES

A. General Considerations

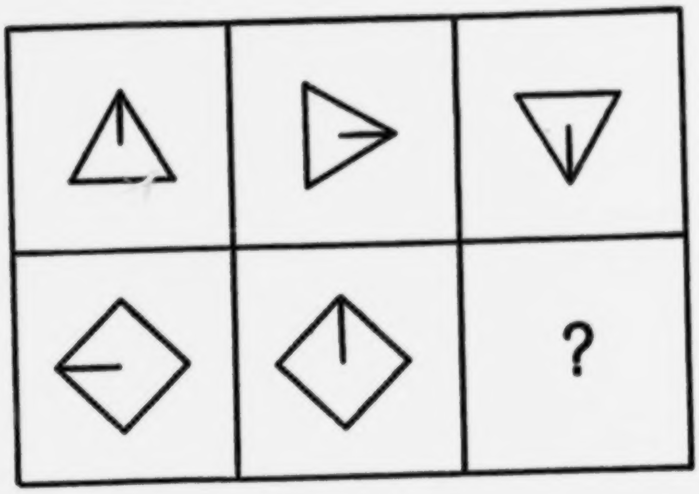
It was determined that the basic aptitude training exercises would cover the areas of non-verbal abstract reasoning, basic mechanics, basic electricity, visualization in two dimensions, and visualization in three dimensions. The practice exercises covered the universe or domains sampled by similar Project Talent tests. The items in the training exercises were similar to test items in format and were presented after the basic principles involved had been discussed. The items were of progressive difficulty and were very easy in the first exercises. Thus each student experienced success on most items. As a result it was found that most students enjoyed taking the exercises. There was no problem with motivation even with groups of potential dropouts and others with poor motivation for most school activity. It was found that immediate feedback of results was not necessary and results on the items were discussed by the teachers at the end of each period. The exercises were organized to cover 30 class periods of 45 minutes each.

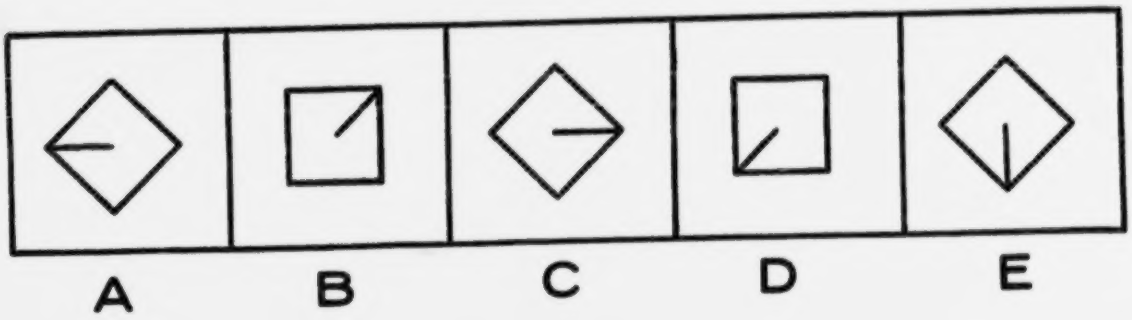
The specific considerations of each of these areas are outlined below.

B. Abstract Reasoning

The Project Talent Abstract Reasoning Test was examined to determine the basic general principles which it sought to measure. A plan was developed whereby most of the various general principles involved were presented step-by-step. A great many very simple items were drawn up. These were then placed in approximate order of increasing difficulty based upon the judgment of the Project staff.

The standard format used in five of the seven exercises in the abstract reasoning area was as follows:





The task is to determine which of the lettered figures properly fills out the pattern in the bottom row as established by the top row of figures.

The correct answer to the above problem is C.

The other type of abstract reasoning used was chosen because it is a common form used to measure abstract reasoning in screening tests, although this type of exercise was not used in Project Talent. The format used for this type of exercise was as follows:

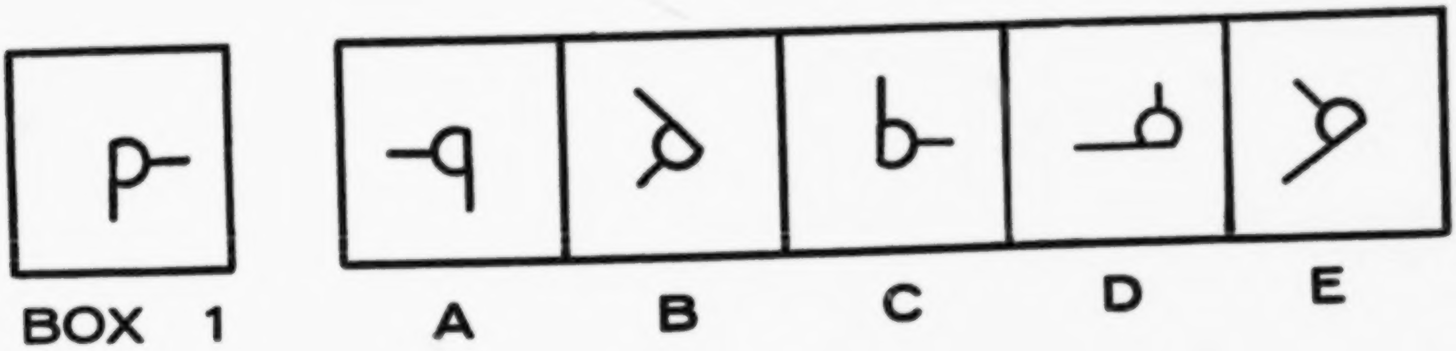
Directions: Fill in the next number of the series in the space to the right.

3, 4, 6, 10, 18, ____

The task is to determine the relationship between each of the numbers in the series and then decide what the next number should be. In the example above the difference between the successive numbers doubles (1, 2, 4, 8). The next number would be 16 more than 18, or 34.

C. Visualization in Two Dimensions

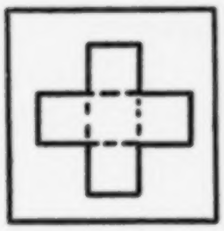
The task involved in the Project Talent test of Visualization in Two Dimensions was rather simple. An example is shown below:



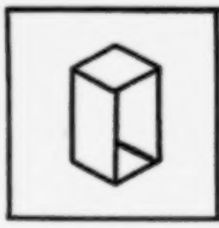
The task is to find the lettered figure that corresponds to the figure in Box 1 except that it is rotated. One of the five lettered figures is the same as the figure in Box 1 except that it has been rotated in the plane of the page. The other four have been "flipped" over. In this example, B is the correct answer. Three exercises of this type were drawn up consisting of a total of 60 questions.

D. Visualization in Three Dimensions

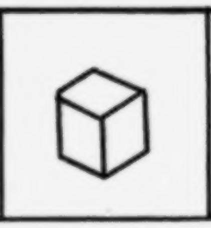
The Project Talent test of Visualization in Three Dimensions was essentially a surface development test. This means that a solid shape was shown to a student as the stimulus part of the question. Then five different flat shapes were shown. The student was asked which one of the five could be folded, bent, or otherwise manipulated to form the solid shape. This technique was used in several of the exercises developed for this project. In addition, however, the reverse system was used. That is, a flat shape was shown as the stimulus and then five three-dimensional shapes were presented with the idea of selecting the one that could be made by folding the flat shape. An example is shown below:



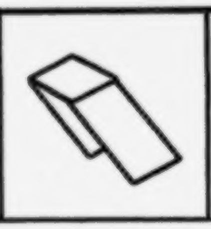
BOX 1



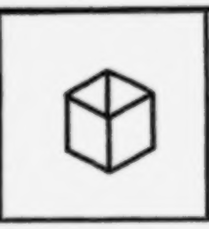
A



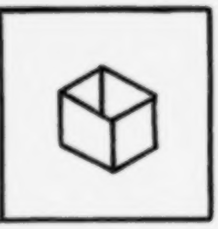
B



C



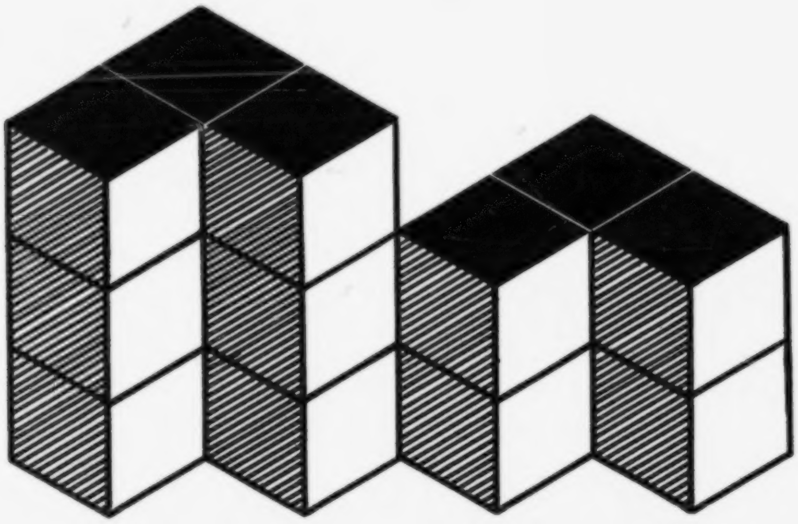
D



E

In this example D is the correct answer.

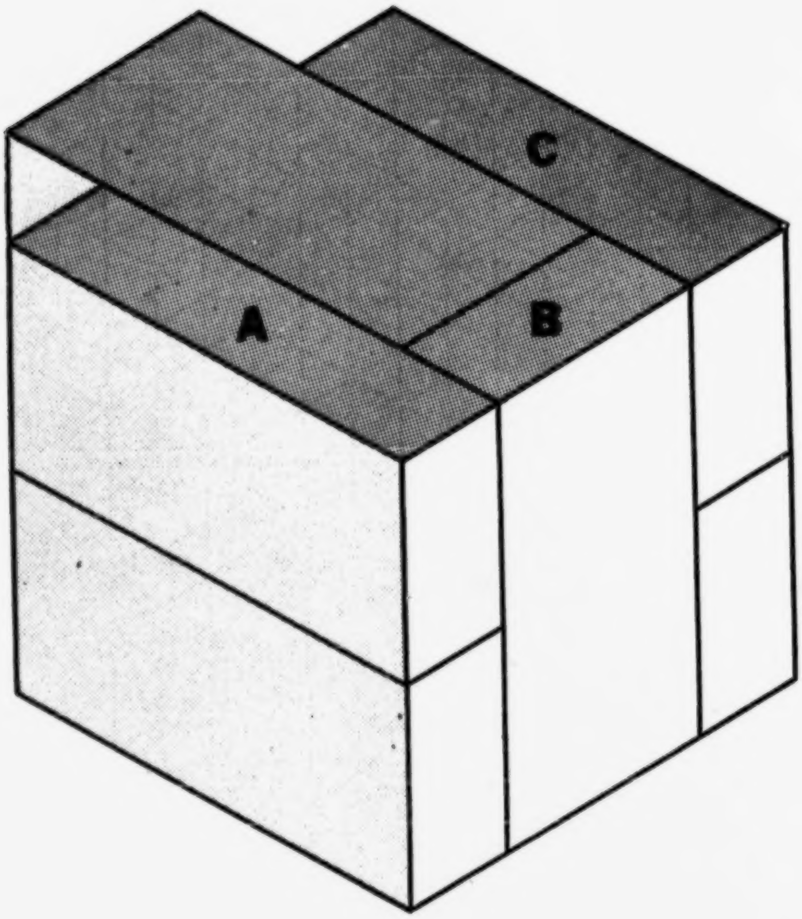
In order to extend the types of exercises in the three-dimensional area, exercises were developed in several aspects of block counting. The simplest form of this type of exercise is to count the number of blocks in a stack as in the example below taken from one of the exercises:



There are nine blocks in the left-hand stacks and six in the right-hand stacks, for a total of 15 blocks.

Another variant of the block and brick counting is illustrated below:

Directions: Assuming that all bricks are the same size, how many other bricks are touching brick A? Brick B? Brick C?



A____

B____

C____

The answers are A = 4, B = 8, and C = 4.

E. Mechanical Aptitude

Mechanical aptitude was considered to include both basic mechanics and basic electricity. The exercises used in Booklet B were modeled after the Information Tests of Project Talent. This consisted of a multiple-choice question concerning mechanical and electrical information with five options. This booklet contains four exercises of 24 questions each. The reasons for the correct answers were given in the back of the booklet.

The other type of mechanical and technical comprehension exercise was based upon a completely different principle. After surveying the types of mechanical and technical principles most frequently found in Project Talent and other mechanical aptitude tests, illustrations were developed for each of them. Then a description of the device or principle was written up in simple terms, referring to the illustration and the labels on the illustration. Then four, five, or six multiple-choice questions were asked about the device which could be answered only after understanding the basic principles involved. The answer booklet which accompanied the exercise booklet contained a brief explanation of why the correct answer was correct.

For example, one of the devices selected for inclusion in the exercises was a simple telephone transmitter. A schematic and semi-schematic diagram was used to show the various parts and circuits. The accompanying text described the various major components and explained how they worked together. Six multiple-choice questions followed the descriptive material and asked about how the device worked.

F. Content of the Exercise Booklets

Exercises from each of the above content areas were distributed among the four booklets as follows (the number of each exercise is indicated):

Subject Matter	Part A	Part B	Part C	Part D	Total
Abstract Reasoning	1,4	8,13	16,20	25	7 exercises
Visualization 2 Dim.	2,5	9	--	--	3 exercises
Visualization 3 Dim.	3,6	11,14	18,22	27,29	8 exercises
Mech. & Tech. Info.	--	7,10,12,15	--	--	4 exercises
Mech. & Tech. Comp.	--	--	17,19,21,23	24,26,28,30	8 exercises
Total	6	9	8	7	30 exercises

G. Answers to Questions in Exercises

For better early reinforcement, answers to the exercise questions were given on the same page in Part A of the exercise booklets. However, it was decided that in Part B having the answers available in the back of the booklet would be sufficient reinforcement. For booklets Part C and Part D, answers were not given in the booklet but rather on a separate answer sheet supplied to the teachers.

Because many of the teachers in the study had little or no background in the mechanical and technical areas, it was decided that some explanation of the correct answers would be supplied. While these answers, of course, could not be exhaustive, they do help the teacher in explaining the questions.

III. LABORATORY EXERCISES

A. General Considerations

The laboratory equipment and simple demonstration devices were designed for use by 9th-grade students to teach those aspects of mechanical ability and basic mechanical and technical comprehension and understanding that are not suitable for teaching by readers or paper-and-pencil exercises. This equipment was used in conjunction with the basic aptitude training exercises. It consisted of very simple, sturdy, table-top equipment designed to demonstrate the principles of levers, gear trains, belts and pulleys, friction, series and parallel circuits, and simple electronic devices. Along with the equipment were student manuals and teacher manuals. The materials were developed for eighteen experiments, but only the first ten were used during the 1965-1966 regular school year. The remaining exercises were tried out during the summer of 1966 in special programs. Table 3-1 shows the subjects covered by each exercise.

Each exercise was designed for teachers who had had no prior training in mechanics or science. The teacher's manual was so written that the apparatus could be assembled and used following simple step-by-step instructions. Appropriate questions were included with each exercise so that the teacher could quiz the students. It was intended that the teacher should go through each exercise once in front of the class, and then the class would break up into small groups and go through the same exercise. The student's manuals were written with this in mind. It was intended that the students would take turns operating the equipment after the teacher's demonstration.

Table 3-1

Vocational Education Laboratory Exercises

Used with Schools

1. Gears and Belts
2. Gears and Belts
3. Gears and Belts
4. Making Weights Balance
5. Levers
6. Friction
7. The Inclined Plane
8. The Pulley
9. Magnets
10. Making Magnets

Developed but Not Used

11. Simple Circuits
12. Series and Parallel Circuits
13. Simple Audio Amplifier
14. Simple Radio Receiver
15. Simple Radio Transmitter

Revision

1. Simple Gears
2. Compound Gears
3. Solving Gear Problems
4. Friction
5. Levers
6. The Wheel and Axle
7. Belts, Pulleys, and Bevel Gears
8. The Inclined Plane
9. The Pulley
10. Determining Weights
11. Magnetism
12. Making Magnets
13. Simple Circuit
14. Series and Parallel Circuits
15. Three-Way Switches
16. Alternating and Direct Current
17. Simple Audio Amplifier and Radio
18. Simple Radio Transmitter

B. Exercise Content

The course was organized into four basic parts: mechanical, magnetism, electrical, and electronics. The mechanical experiments included work with gears, friction, levers, wheel and axle, belts, pulleys, inclined plane, and simple balance scales. Magnetism included the laws of polarity, repulsion and attraction, lines of force, and making a magnet. Electrical experiments covered simple circuits and switches, series and parallel connections, three-way switches, and an experiment to show the difference between alternating and direct current. Electronics experiments covered the building of an audio-amplifier, and then converting it to a simple radio and making a simple radio-transmitter. Further details will be found in Appendix B-3.

IV. BASIC READERS

A. General Considerations

It has been found that one of the greatest problems in keeping marginally trainable students in school and willing to learn is the lack of interesting, down-to-earth, reading materials. It was the intention of this project to interest pre-vocational students in mechanical and technical subjects. For that reason the readers that were to accompany the instructional materials were written with the following considerations:

1. Understandable and interesting for culturally disadvantaged 8th and 9th graders who were poor readers

2. Profusely illustrated

3. Expository in style

4. Contain fundamental information in mechanics and technology needed for later specialization

All text materials were typed double-space with wide margins. The length of lines seldom exceeded five inches, and wherever possible simple words and short sentences were used. Paragraphs were usually staggered on the page and separated by extra spacing.

The role of the basic readers as part of the integrated curriculum for teaching basic vocational talents was envisioned as being much broader than merely training in the specific skills measured by such tests as abstract reasoning, mechanical reasoning, and spatial visualization. It was planned to interest students in a broad background of the basic concepts, knowledge, and skills involved in basic mechanics and technology. In accomplishing this, the readers had two purposes. One was to present specific information in the application of mechanical principles, and the other was to help give a broad background of basic concepts and principles in the field of technology.

It was also believed that students need to have a background of information on what the workers in various skilled occupations do. This is an essential part of their basic pre-vocational instruction which they need before choosing their specific job training in the 10th grade. Another purpose was to help motivate them by using material having a high interest value.

B. Readability Consideration

A study of the literature on formulas for determining readability level was made. It was concluded that there is no satisfactory scale or accepted scientific procedure which can establish the readability level of materials in advance of their writing. The formula-type criteria are useful as guides but are no substitute for the professional judgment of the authors. It is firmly believed, too, that the weaknesses of the formula approaches to this problem are particularly serious with the writing of materials in the mechanical and technological area. There seems to be a consensus that the content of the material is the predominant factor leading to its readability level, particularly in the mechanical and technological area.

With the exception of technical terminology, the materials were all written at very easy levels according to conventional readability criteria. It is strongly believed that the criterion of "unusual words" does not apply at all in the mechanical or technological area, since almost all of the words in that area are unusual as far as general written materials are concerned. It has been found that many of these words which may be unusual from the point of view of conventional word lists are not very unusual to most of the 8th-grade boys who are poor readers. If they don't know some of the words, they don't at all mind having them included in the texts. There is some evidence that they are challenged to want to know the words that they do not already know.

It is considered doubtful that any of the current word lists have much relevance to estimating the grade level of mechanical or technological material designed for use with educationally disadvantaged adolescents. These word lists are based on literary material that is almost completely devoid of technological content. This material is also heavily flavored with rural and middle-class culture. Clarence R. Stone's revision of the Dale List of 769 Easy Words (Spache, 1966), for example, includes many words that may not be familiar to poor readers among urban disadvantaged youth. On the other hand, many words such as ignition, generator, hydraulic, lubrication, distributor, cylinder, transmission, differential, or carburetor, are found to be easily acquired and understood by most disadvantaged 8th- and 9th-grade students.

It was decided, therefore, that the primary guide to determining the difficulty level of materials to be used would be to try materials out informally on groups of disadvantaged adolescents known to be at the 6th-grade level on paragraph comprehension tests. This was done with several in-school and out-of-school groups.

In preparing the readers, efforts were made to keep the vocabulary as simple as possible. However, some words and material at higher than 6th-grade level in some instances were included to challenge the students to broaden their vocabularies. It is being found that an occasional word the student does not know does not deter him if he is basically interested in the material and is able to understand most of it.

C. "Transportation Long Ago"

This was a large size (11" x 17") 64-page booklet. The illustrations and much of the text were taken from early issues of the *Scientific American*, from 1898 to 1918. The following modes of transportation were included:

Airplanes
Balloons
Dirigibles
Helicopters
Locomotives
Sailing Ships
Automobiles
Racing Cars

There were many illustrations and advertisements of old mechanical equipment. In the first part of the booklet simple captions and text were used with each picture. Further along in the booklet, text was included from the original magazines. As a result, reading matter of varying difficulty can be found from very elementary to advanced levels.

This booklet has been found to be quite interesting to a broad range of children, adolescents, and adults.

D. "The Automobile"

One of the mechanical topics almost universally liked by disadvantaged teen-age boys is antique automobiles, the subject of this reader.

The booklet was 8½" x 11" in size and contained 96 pages. It was divided into three parts:

Part A -- The Model T Ford
Part B -- The Model A Ford
Part C -- Cadillacs and Other Old Cars

The margins of this booklet were broken up by staggering the paragraphs alternately in and out. In addition, extra space was left between paragraphs. The text was typed double-space. Wording was made as simple as possible consistent with the technical subject being treated.

In each part the major mechanical features were illustrated and described. Among the topics included for discussion are the carburetor, axles, driveshafts, universal joints, brakes, internal combustion engines, and the lubrication and cooling systems.

E. "Transportation Today and Tomorrow"

This booklet was 8½" x 11" in size and contained 128 pages. It was designed to present modern transportation, in contrast to Transportation Long Ago. It contained the following sections:

1966 model United States automobiles
Selected foreign automobiles
Civilian and military airplanes
Missiles and spacecraft
Atomic energy and its applications

It also contained short articles on the gasoline engine, the diesel engine, what horsepower is, and how the gearshift works. To add to the general interest, four simple crossword puzzles were constructed using names of various makes and models of automobiles and automotive terms.

As with The Automobile, the text was typed double-space with staggered margins for each paragraph, and with extra space between paragraphs.

F. "Tools and Basic Machines"

This booklet was 8½" x 11" in size and contained 112 pages. The format was similar to the two booklets previously described. Much of the basic materials used in this booklet was taken from U.S. Navy training publications and manuals. The pictures from these manuals were used, but the text was considerably shortened and simplified. In general, a picture or drawing was presented with a caption, followed by a brief description of the tool and its uses.

In addition to the section on hand tools, there were sections on power tools, fastening devices (such as nails, screws, bolts, etc.), basic machines (such as the lever, the wedge, gears, pulleys, etc.), and farm equipment (such as various tractors and their attachments).

This booklet was considered to be very important to city students as they have a very limited opportunity to learn about hand and power tools, machines, and farm equipment, all of which have fundamental applications of mechanical principles.

G. "Occupations for You, Part One"

This reader was 8½" x 11" in size and contained 168 pages. Its primary purpose was to present information that might interest boys and girls going into vocational schools with regard to various kinds of jobs. The basic information was obtained from Department of Labor occupations briefs, supplemented by information from other authoritative sources. There were 31 different occupations presented, with a maximum of ten pages and a minimum of four pages for each. Each section showed a picture of persons working in the occupation described. Each section attempted to answer the following questions:

What people do in this occupation
Training and other requirements
Earnings and working conditions
Employment outlook
Where to get more information

In addition, a brief thumbnail sketch of each occupation was given at the head of each section. This included the weekly pay, type of work, education requirements, and training required.

Also presented in the back of the booklet was a brief glossary, and a section for converting hourly wages to weekly, monthly, or yearly pay. Another section, which proved to be very popular, was a diagram showing the relative salary schedules of all the occupations described in the booklet. The highest paid occupation shown on this diagram was the heavy equipment operators, and the lowest was the gasoline service station attendant.

H. "Occupations for You, Part Two"

This reader has the same format as Part One and covers the common occupations not included in Part One. This reader was developed too late to be used in the study. A copy of the developed manuscript is also included as an attachment to this report. See Appendix B for details of content.

I. Suggestions to Classroom Teachers for the Use of the Readers

It was decided not to have standardized instruction for the use of the readers because no separate time was to be scheduled for their use. It was expected that each school would use them with the groups of students receiving the special instruction. It was believed preferable to give the teachers latitude in using them in a variety of ways during regular class activities.

As a result, the following suggestions were given as to how the readers might be used in class:

1. Use as reading assignments for extra credit in reading or in English.

2. Use as texts for remedial reading classes.

3. Use as a basis for class discussion.

4. Use as a basis for writing themes.

5. Use in shop classes.

6. Use in mathematics to find applications of mathematics to technology.

7. Use to present occupational information through a course in "Occupations" as basic or supplementary reading materials. Some time might be spent on vocabulary-building exercises relative to the various occupations. A teacher might also find it appropriate to include a discussion of how one enters the various occupations, taking some time to supply information about the informal and formal training required.

8. Utilize to supply occupational information in social sciences or civics course. The Occupational Readers might be used as supplementary material for classroom discussion or outside reading material to promote or advance the interests demonstrated by members of the class.

9. Use by the guidance counselor, who might incorporate the readers in guidance classes or other situations to present "the world of work." Those guidance counselors would find this material useful as a follow-up to the discussion of the individual's or group's abilities, aptitudes, and interests as obtained from various interest inventories and other objective and subjective measurement procedures.

10. Schools might give each student a set of readers and allow him to take them home for outside study and use. One set per student in the experimental group was provided. However, the school used its own judgment about how to issue and use them. Ample opportunity was to be given for the students to read and study them on their own time.

Chapter 4

ANALYSIS OF DATA AND FINDINGS

In this chapter are reported the results of analyses of the pre-test and post-test data. Test gains are compared for Project Talent tests related to the material taught and for tests unrelated to the material. Male gains were compared with female gains. Amount gained during the demonstration was also compared with the average yearly gain on each test found by Project Talent between grades 9 and 12. Analyses were also made of changes in factor structure from test to retest.

Retest Gain

The students in the study were administered selected Project Talent tests at the beginning of the school year and were retested during the last month of school. The means and standard deviations for the thirteen tests administered before and after the use of the curriculum materials are shown in Table 4-1. There are five main groups of students: 8th-grade boys, 8th-grade girls, 9th-grade boys, 9th-grade girls, and 10th-grade boys.* Only complete cases (students who had all the test scores for the two sets of tests) are included in the table. This included all schools except John Roberts in New York City. It will be seen that there are gains on every single test for all groups. The lowest gain is shown for the Biological Sciences Information test in the 9th-grade girls group, where the mean post-test raw score (rights only) is only 0.007 greater than the pre-test. The largest raw score gain was in Visualization in Two Dimensions in the 10th-grade boys group, where a gain of 5.835 raw score points was obtained.

There are a number of ways in which gains between pre-tests and post-tests can be interpreted. Obviously, stating gains in raw scores alone is not meaningful. However, one might compare the gains on various tests in terms of relative gain in the percentage of items marked correctly in each test. Another method might be to translate the gains into z scores based upon their standard deviations. Both of these methods give meaningful comparisons. However, for this study the most meaningful comparison is obtained by comparing the gain with the average amount of gain per year found in a Project Talent longitudinal study (Shaycoft, 1967). Data from this study are shown in Table 4-2.

Table 4-2 shows the means, standard deviations, sample size, and other data about the same thirteen tests that were used in the present

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* This experimental group contained several 11th-grade boys.

Table 4-1. Means and Standard Deviations for Pre-test and Post-test Raw Scores*

	No.	Grade 8 Males (N=567)				Grade 9 Males (N=582)				Grade 10 & 11 Males (N=54)			
	of	Pre-test		Post-test		Pre-test		Post-test		Pre-test		Post-test	
Test	Items	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Abstract Reasoning	15	6.799	2.929	8.150	2.856	7.811	2.976	9.510	2.680	7.093	2.333	8.093	2.459
Mechanical Reasoning	20	7.808	3.595	9.328	3.773	9.282	3.684	10.892	3.963	8.000	3.336	9.185	3.787
Arithmetic Reasoning	16	4.728	2.613	5.321	2.779	5.916	2.902	6.766	3.345	4.370	2.467	4.574	2.034
Visual'n in 2 Dimensions	24	9.891	5.594	14.808	5.853	11.301	5.741	16.479	5.300	8.796	5.444	14.630	6.617
Visual'n in 3 Dimensions	16	6.190	2.607	7.448	2.935	6.960	2.896	8.716	2.984	6.315	2.711	8.333	3.398
Reading Comprehension	48	17.332	8.124	19.208	9.162	22.538	9.629	25.325	10.418	14.889	6.911	17.500	8.093
Information:													
Vocabulary	21	7.903	3.873	8.559	4.028	10.002	3.235	10.995	3.989	5.944	2.722	8.741	3.519
Math	23	4.675	2.473	5.452	3.153	6.284	3.134	7.615	3.805	4.481	2.463	5.426	2.859
Physical Sciences	18	6.247	3.384	6.638	3.545	8.050	3.758	9.301	3.776	4.241	2.569	5.667	2.411
Biological Sciences	11	4.160	2.294	4.534	2.314	5.122	2.184	5.414	2.283	3.463	1.870	4.778	2.151
Aeronautics & Space	10	3.123	1.965	3.407	2.076	3.900	2.229	4.471	2.204	2.389	1.709	4.037	2.410
Elec'y & Electronics	20	5.556	3.430	6.266	3.686	7.201	3.717	8.464	4.022	4.148	2.638	5.111	3.385
Mechanics	19	7.099	3.384	7.700	3.579	8.675	3.396	10.137	3.633	6.315	2.417	9.167	3.341

	No.	Grade 8 Females (N=100)				Grade 9 Females (N=162)			
	of	Pre-test		Post-test		Pre-test		Post-test	
Test	Items	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Abstract Reasoning	15	4.380	2.291	6.560	2.844	5.914	2.713	7.747	2.780
Mechanical Reasoning	20	4.510	2.427	5.270	2.256	5.568	2.316	6.556	2.833
Arithmetic Reasoning	16	4.030	2.665	4.320	2.640	4.340	2.249	5.012	2.780
Visual'n in 2 Dimensions	24	5.810	3.614	10.790	5.972	7.352	4.451	12.944	6.005
Visual'n in 3 Dimensions	16	5.060	2.145	6.260	2.658	5.679	2.302	7.111	2.844
Reading Comprehension	48	13.650	6.316	15.150	7.623	18.605	8.228	20.049	9.288
Information:									
Vocabulary	21	5.070	2.516	6.130	3.274	6.938	2.637	7.994	3.212
Math	23	4.140	2.089	4.620	2.485	4.815	2.661	5.877	2.568
Physical Sciences	18	4.120	2.171	4.470	2.993	5.191	2.622	6.488	2.758
Biological Sciences	11	3.060	1.819	3.490	2.418	4.012	1.962	4.019	1.718
Aeronautics & Space	10	2.090	1.531	2.220	1.593	2.580	1.368	2.920	1.572
Elec'y & Electronics	20	3.430	2.105	4.470	2.057	4.049	2.093	4.710	2.310
Mechanics	19	4.140	2.265	4.900	2.488	5.148	2.368	6.025	2.587

* Scored for number of right answers only

Table 4-2

Means and Standard Deviations for Project Talent Retest Data[1] (Grade 9 and Grade 12)

		No. of Items	N		MEAN						STANDARD DEVIATION			
					Gr. 9		Gr. 12		Raw Score Difference		Gr. 9		Gr. 12	
			M	F	M	F	M	F	M	F	M	F	M	F
R-290	Abstract Reasoning	15	3382	3628	8.75	8.51	10.15	9.74	1.40	1.23	3.00	2.96	2.84	2.95
R-270	Mechanical Reasoning	20	1795	1839	11.88	8.25	14.28	9.84	2.40	1.59	3.93	3.41	3.82	3.69
R-311	Arithmetic Reasoning	16	1686	1817	7.98	7.65	10.14	9.18	2.16	1.53	3.38	3.20	3.60	3.59
R-281	Visual'n 2 Dimensions	24	1795	1839	13.14	11.15	16.18	13.59	3.04	2.44	5.70	5.51	5.43	5.55
R-282	Visual'n 3 Dimensions	16	1795	1839	8.59	7.86	10.44	9.09	1.85	1.23	3.21	2.92	3.34	3.06
R-250	Reading Comprehension	48	1795	1839	26.62	28.14	32.93	34.13	6.31	5.99	10.56	10.07	10.71	9.56
	Information													
R-102	Vocabulary	21	1761	1917	11.97	10.67	14.57	13.34	2.60	2.67	3.80	3.86	3.71	4.09
R-106	Mathematics	23	1761	1917	7.93	7.05	12.24	9.16	4.31	2.11	4.03	3.61	6.35	5.88
R-107	Physical Sciences	18	1761	1917	9.67	7.84	11.25	8.37	1.58	.53	3.69	3.51	4.26	4.04
R-108	Biological Sciences	11	1761	1917	5.95	4.88	7.15	6.03	1.20	1.15	2.28	2.14	2.13	2.24
R-110	Aero. & Space	10	1761	1917	4.59	2.76	5.92	3.64	1.33	.88	2.35	1.64	2.40	1.92
R-111	Elec'y & Electronics	20	1761	1917	8.56	5.55	11.25	6.25	2.69	.70	3.87	2.54	4.61	3.14
R-112	Mechanics	1[illegible]	1761	1917	11.14	7.18	13.56	8.79	2.42	1.61	3.28	2.72	3.15	3.02

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[1] Based on matched retest cases. For each variable all cases were used that had scores (rights only) for both grade 9 and grade 12.

From Table 4-9 of "The High School Years: Growth in Cognitive Skills". (Interim report 3 to the U.S. Office of Education, Cooperative Research Project No. 3051) Shaycoft, Marion F. Pittsburgh: Project Talent Office, 1967.

study. The Project Talent tests were originally administered in 1960. The same tests were readministered to those students who were still in the same schools and in the 12th grade in 1963. The raw score differences (scored rights only) indicate the amount of gain that would normally be expected over a three-year period for boys and girls who have not been held back, dropped out, or transferred to another school between the 9th grade and the 12th grade.

Table 4-3 compares the gains of each group in the present study with the average yearly gain in Project Talent (Shaycoft, 1967) on each of the thirteen tests. This is done by dividing the mean difference between the pre-test and post-test by the boy and girl annual gain from Project Talent and showing this ratio in each case. The range of the ratio is from 0.02 for Biological Sciences Information for grade 9 girls to 7.21 for the same group in Physical Sciences Information.

If the ratio were 1.00 then the gain in the experimental group would be the same as for the average gain per year in Project Talent.

It will be noted that the gains are considerably higher in those subjects specifically taught by the curriculum material of the present project. These were:

Abstract Reasoning
Mechanical Reasoning
Visualization in Two Dimensions
Visualization in Three Dimensions
Physical Sciences Information
Electricity and Electronics Information
Mechanics Information

Gains are not so large for subject matter not specifically taught by the curriculum materials. These were:

Arithmetic Reasoning
Reading Comprehension
Vocabulary Information
Mathematics Information
Biological Sciences Information

Additional data were gathered during the course of the demonstration and will be valuable to add to the analyses when follow-up data become available. Such data include information on student background and interests.

Table 4-3

Comparison of Gains in Raw Score between Pre-Test and Post-Test in Present Study with the Average Yearly Gains in Raw Score in Project Talent*

	B O Y S							G I R L S				
	$(M_2 - M_1)$**			Yrly Gain PT	$(M_2 - M_1) \div$ PT***			$(M_2 - M_1)$**		Yrly Gain PT	$(M_2 - M_1) \div$ PT***	
Test	Gr.8 N=567	Gr.9 N=582	Gr.10 N=54		Gr.8	Gr.9	Gr.10	Gr.8 N=100	Gr.9 N=162		Gr.8	Gr.9
1. Abstract Reasoning	1.351	1.699	1.000	.47	2.874	3.615	2.128	2.180	1.833	.41	5.317	4.471
2. Mechanical Reasoning	1.520	1.610	1.185	.80	1.900	2.012	1.481	.760	.988	.53	1.434	1.864
3. Arithmetic Reasoning	.593	.850	.204	.72	.824	1.181	.283	.290	.672	.51	.569	1.318
4. Visual'n in 2 Dimens.	4.917	5.178	5.834	1.01	4.868	5.127	5.776	4.980	5.592	.81	6.148	6.904
5. Visual'n in 3 Dimens.	1.258	1.756	2.018	.62	2.029	2.832	3.255	1.200	1.432	.41	2.927	3.493
6. Reading Comprehension	1.876	2.787	2.611	2.10	.893	1.327	1.243	1.500	1.444	2.00	.750	.722
Information:												
7. Vocabulary	.656	.993	2.797	.87	.754	1.141	3.215	1.060	1.056	.89	1.191	1.187
8. Math	.777	1.331	.945	1.44	.540	.924	.656	.480	1.062	.70	.686	1.517
9. Physical Sciences	.391	1.251	1.426	.53	.738	2.360	2.691	.350	1.297	.18	1.944	7.206
10. Biological Sciences	.374	.292	1.315	.40	.935	.730	3.288	.430	.007	.38	1.132	.018
11. Aeronautics & Space	.284	.571	1.648	.44	.645	1.298	3.745	.130	.340	.29	.448	1.172
12. Elec'y & Electronics	.710	1.263	.963	.90	.789	1.403	1.070	1.040	.661	.23	4.522	2.874
13. Mechanics	.601	1.462	2.852	.81	.742	1.805	3.521	.760	.877	.54	1.407	1.624

* Shaycoft, 1967

** $(M_2 - M_1)$ = difference between mean of post-test and pre-test

*** Ratio of mean difference to yearly gain in Project Talent sample

Further analyses of data on the performance of students who participated in the training program should also be done when it is possible to relate them to follow-up data on how well the students do later in vocational training.

Boys versus Girls

The comparison of the differences in gains between boys and girls is interesting. Table 4-4 summarizes these for grade 9. In this table, gain has been computed as the percentage increase in raw score using the number of items in the test as 100%.

It will be noted that the average gain for boys in the Project Talent column is surprisingly constant. However, this is easily understood because the Project Talent tests were specifically designed as a coordinated battery of tests. As a result, their distributions of item difficulties and raw score percentage right distributions are highly similar. It is found that boys, who tend to be exposed to learning in all of these areas in and out of school during the high school years, apparently learn at about the same rate in all areas. On the other hand, girls, who have little exposure to learning opportunities in some of these areas, learn at a much slower rate than do boys. In areas where boys and girls have equal exposure, the girls learn as fast as the boys. The girls in the experimental group showed substantial learning in some technological areas in which the girls in Project Talent learned very little. This indicates that girls can probably learn as fast as boys in these areas if they have equal exposure to them. The curriculum materials developed in this study apparently give girls the chance to develop fundamental skills and knowledges in technology just as well as boys. If these materials are used extensively during the junior high school years, they should minimize the traditional sex differences on mechanical and technological aptitude tests. If done, this could possibly influence many more girls to consider careers and occupations other than the ones most of them have usually entered.

Correlational Studies

The matrices of intercorrelations of the pre-test and post-test batteries are shown in Appendix A of this report.

Table 4-5 shows the correlation for each test between the original scores and those made on the retest administration. Table 4-5 also shows the test-retest results for Project Talent from grade 9 to grade 12. In general these test-retest correlations are substantially lower than the reliabilities of the tests for national groups when initially administered at the 9th-grade level. The primary reason for this is the relatively low achievement of these groups compared with nationally representative samples. The mean scores of the 10th-grade male group are substantially lower than those of the 9th-grade male group. The mean pre-test score in

Table 4-4

Percentage Gain in Raw Score for 9th-Grade Males and Females
Compared with Similar Data from Project Talent

	Test	MALE (N=582)		FEMALE (N=162)	
		Raw Score Gain in % Grade 9	P.T. Average Annual % Gain Grade 9-12**	Raw Score Gain in % Grade 9	P.T. Average Annual % Gain Grade 9-12**
1.	Abstract Reasoning*	10.7	3.1	12.2	2.7
2.	Mechanical Reasoning*	8.1	4.0	5.0	2.6
3.	Arithmetic Reasoning	5.3	4.4	4.2	3.2
4.	Visualization in 2 Dimensions*	21.6	4.2	23.3	3.4
5.	Visualization in 3 Dimensions*	11.0	3.9	8.9	2.6
6.	Reading Comprehension	5.8	4.4	3.0	4.2
7.	Vocabulary Information	4.7	4.1	5.1	4.2
8.	Math Information	5.8	6.2	4.6	3.0
9.	Physical Sciences Information*	7.0	2.9	7.2	1.0
10.	Biological Sciences Information	2.6	3.6	0.0	3.5
11.	Aeronautics & Space Information	5.7	4.3	3.4	2.9
12.	Electrical & Electronics Info.*	6.3	4.4	3.4	1.2
13.	Mechanical Information*	7.7	4.2	4.6	2.8

*Training-related tests

**Shaycoft, Marion F. The High School Years: Growth in Cognitive Skills (Interim Report 3 to USOE, Coop. Project No. 3051) 1967

Table 4-5

Correlations between Scores on Test and Retest
for 8th- and 9th-Grade Boys and Girls and 10th-Grade Boys
Compared with Project Talent Correlations of 9th- with 12th-Grade Scores

Test	8 M N=567	9 M N=582	10 M N=54	8 F N=100	9 F N=162	Project Talent Grade 9-12*	
						M	F
1 Abstract Reasoning	.562	.561	.459	.584	.586	.568	.601
2 Mechanical Reasoning	.681	.736	.545	.370	.493	.658	.640
3 Arithmetic Reasoning	.548	.686	.104	.617	.500	.650	.679
4 Visual'n in 2 Dimens.	.528	.570	.424	.370	.602	.492	.571
5 Visual'n in 3 Dimens.	.569	.614	.318	.489	.496	.601	.592
6 Reading Comprehension	.751	.840	.415	.689	.813	.712	.771
Information:							
7 Vocabulary	.742	.796	.449	.464	.611	.741	.764
8 Math	.530	.666	.351	.355	.588	.716	.686
9 Physical Sciences	.684	.783	.290	.562	.653	.750	.716
10 Biological Sciences	.631	.662	.127	.528	.649	.638	.615
11 Aeronautics & Space	.592	.684	.105	.478	.308	.673	.474
12 Elec'y & Electronics	.725	.732	.216	.223	.410	.703	.449
13 Mechanics	.675	.748	.440	.462	.486	.648	.575

* Tested in grade 9 and retested in grade 12. N's vary among tests. For exact N's, see Table 4-2.

Arithmetic Reasoning is near the chance level and thus correlates only .104 with itself on retest. The test-retest correlations for girls tend to be substantially lower than those for the boys on those tests where the girls make substantially lower scores. The 8th-grade girls mean pre-test score in electrical information was only 3.43 on the 20-item test.

Factor Analyses

A series of factor analysis studies* were made of the intercorrelations of the combined pre-test and post-test batteries for grades 8 and 9 male and female to determine how the factorial structure of the tests had changed at the end of the talent training that was given. Approximately seven months intervened between the pre-tests and the post-tests. The results of these analyses are shown in Tables A-1 to A-4 in Appendix A. The intercorrelations which were factored are shown in Appendix A, Tables A-5 to A-8.

The results were relatively consistent for the boys as the factor patterns of the post-tests were quite similar to those of the pre-tests. There was much less similarity between pre-test and post-test results for the girls. The factor patterns for Grades 8 and 9 were similar for the boys but much less similar for the girls in the two grades.

More factors emerged for the girls. There were nine factors produced for grade 8 girls and ten for grade 9 girls, while grade 8 boys had only six factors and grade 9 boys had five. The additional factors for the girls were factors defined primarily by retests. No retest factors were found for the boys. In general, the factor patterns for the girls were substantially different from those of the boys. It is hypothesized that this difference is a reflection of the vastly different exposure of boys and girls to mechanical and technical experience, both in and out of school. Prior to the talent training, most of the girls had had near zero exposure to many types of mechanical and technological experiences. Accordingly, the relatively few hours of talent training had a substantial effect. This was reflected in appreciable gains on tests where performance was near the chance level in the pre-tests. This caused the corresponding post-tests to have substantially greater reliabilities and a higher general level of intercorrelations with other tests and this generated several factors primarily defined by post-tests. This is especially true for the grade 8 girls where five retest factors emerged. The grade 9 girls had one retest factor and the boys had none.

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*Program written by Dr. Arthur D. Kirsch of The George Washington University. For details of the Varimax Rotation, see Harmon, Harry H., Modern Factor Analysis, Chicago: University of Chicago Press, 1960.

For such academic tests as reading, arithmetic, vocabulary, and mathematics where girls had had ample exposure, factor patterns were relatively consistent from pre-test to post-test, and were similar for boys and girls and from grade 8 and grade 9.

Only three factors were found to appear consistently in each of the four samples, for both grades and both sexes. The most consistent factor to emerge was defined primarily by three dimension spatial visualization. For the boys, two dimension spatial visualization had little loading on this factor, nor did the other tests. However, for grade 9 girls, two dimension spatial visualization had high loadings on the factor. This did not happen for grade 8 girls but, for them, abstract reasoning had a high loading on the factor.

A clearly verbal factor was found for all four groups. In all cases, reading comprehension had a high loading on this factor but different groups varied in the extent to which other tests had loadings on the verbal factor. For grade 8 girls, vocabulary and biology had high verbal loadings. For grade 9 girls, abstract reasoning and vocabulary had high verbal loadings. For grade 8 boys, vocabulary and biology had high verbal loadings. For grade 9 boys, vocabulary, mathematics, arithmetic reasoning, physical sciences, and biology had high verbal loadings.

A mathematics factor emerged for all four groups. This factor was relatively independent of other tests for grade 8 boys and grade 9 girls, but more mingled with other tests for grade 9 boys and grade 8 girls. For grade 8 girls, mechanical information had a high loading on the mathematics retest factor. A mathematics pre-test factor also appeared. For grade 9 boys, the mathematics factor had high loadings for several of the verbal tests.

Where performance on any of the talent tests was near the chance level the factor structure of such tests was unstable and subject to considerable change from relatively small amounts of additional learning on the tests involved. This was found to be true of the girls as a whole and for several sub-groups of the boys in especially culturally disadvantaged urban areas. This would indicate that talent or aptitude tests are very unstable and difficult to interpret for groups scoring very low on them. This includes many groups in low-income areas. Counselors should be very wary of interpreting such tests on the basis of test validation analyses performed with national samples.

It can be concluded from these analyses that 30 to 60 hours of special training can make substantial changes in the factorial structure of tests but that it does not necessarily produce such changes in all cases. For some groups and for some types of tests, the special training can cause substantial gains on the tests without much change in the factor structure of the tests.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

This study has demonstrated that important aptitude test skills or vocational talents can be taught to a significant degree with relatively simple materials and procedures within typical public school systems. This has many important implications for the theory of measurement as well as for the general fields of compensatory education and special training for the culturally deprived.

The following conclusions and recommendations seem warranted on the basis of the study:

Conclusions

1. Important vocational talents can be taught directly in schools or in other training programs using the new curriculum and materials developed for this purpose in this project. These talents include mechanical reasoning, mechanical information, nonverbal abstract reasoning, spatial visualization, physical sciences information, and electrical and electronics information. The increase in level of talent should help the students to learn the specific skills and understandings taught in vocational high schools or other training programs.

2. No "general test-taking skill" was found. Training on one sort of skill did not affect test performance on different skills not taught. Training in mechanics, for instance, did not help in taking arithmetic or reading tests.

3. As compared with their usual annual gain on tests of basic vocational talents, girls tended to gain more than did the boys. If girls have equal exposure to learning opportunities in technological areas they seem to be able to develop basic vocational talents as well as do the boys. The use of the new curriculum with girls could do much to minimize sex differences in basic technological skills. This could be an important factor in encouraging more girls to enter careers in engineering or the physical sciences.

4. On the tests related to the content of the laboratory course the 9th-grade students who had the training showed more gain than did the 8th-grade students who did not.

5. Mechanical talent or aptitude appears to be a skill largely learned through a variety of out-of-school experiences. A rural or small-town environment is particularly rich in such experiences, and mechanical comprehension has been well named "barnyard physics." This study has demonstrated that our schools and other training programs can compensate for the lack of environmental stimulation in mechanics and technology that handicaps most of our young people today.

6. Nonverbal test skills seem to be as easily modifiable by training as are verbal test skills. It seems likely that most nonverbal skills are as much influenced by past opportunities for learning them as are verbal skills.

7. Talent training can cause changes in the basic intercorrelational characteristics of tests and in their factorial structure. The amount of change appears to be greatest for those groups with least previous opportunity to learn the skills sampled by the tests. For tests of technological talent, such groups include girls and many groups of boys in especially culturally disadvantaged urban areas.

8. Culturally disadvantaged students can be trained to do substantially better on important tests of vocational aptitudes or talents. This could qualify appreciably greater numbers for military, governmental, or industrial training programs where selection is based on aptitude tests.

Recommendations

1. The teaching of basic vocational talents should be incorporated into the regular 8th- and 9th-grade curriculum for all students in urban schools. This could be one or two periods a week as in this study or in more concentrated courses as appropriate. Particular consideration should be given to incorporating it into summer programs for the culturally disadvantaged youth.

2. The curriculum and materials developed are also recommended for use in adult basic and pre-vocational education, programs for institutionalized delinquents, tutorial programs, and for Armed Forces basic or pre-basic training.

3. Research should be initiated to study the long-range effects of talent training and to explore additional applications of the approach. These might include the following:

a. The inclusion of technological material in the lower grades in regular and remedial reading programs. Most materials now used have little or no technological content.

b. The use of the curriculum and materials in emerging nations to supply the basic technological skills necessary as a foundation for the training of engineers and technicians.

c. The use of the curriculum and materials in short concentrated courses to assess how well students learn various technological skills and concepts and how well they like learning them. On the basis of this, they can be guided into appropriate long-range training courses. The primary purpose of the programs would be to give students a chance to learn the basic talents underlying success in training for technological careers. On the basis of how well they learn the various basic technological skills and concepts and how well they enjoy learning them, they can be guided into existing high school, junior college, industrial or other post-high school programs for technological careers. This could be a new approach to the problem of identifying and developing the latent talents of students from a wide variety of backgrounds, who may not have had an adequate chance to learn the skills and concepts sampled by existing occupational aptitude tests. In effect, such programs could serve as an aptitude test and also an interest test. The students could discover their real talents and interests, and the school could assess their patterns of potential for success in advanced technological training in vocational courses, junior college, or similar programs. These programs might be easily carried out in conjunction with other special summer programs.

d. The development and evaluation of materials and methods for training in the full spectrum of talents.

APPENDIX

TO

DEVELOPMENT OF A CURRICULUM AND MATERIALS FOR TEACHING BASIC VOCATIONAL TALENTS

Appendix A	Correlational and Factor Analysis	p. 41
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Appendix A

CORRELATIONAL AND FACTORIAL ANALYSES

In Tables A-1 to A-4 are shown the rotated factor loadings derived from each matrix of correlations which are shown in Tables A-5 to A-8. The rotations are by the varimax method* and are for all factors accounting for as much as three percent of the total variance. The tables are discussed in Chapter 4.

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*Program written by Dr. Arthur D. Kirsch of The George Washington University. For details of the Varimax Rotation see Harmon, Harry H., Modern Factor Analysis, Chicago: University of Chicago Press, 1960.

Factor Definitions* for Table A-1

Grade 8 - Male

I. Technical Information

II. Three-dimension Spatial Visualization

III. Verbal

IV. Two-dimension Spatial Visualization

V. Mathematics Information

VI. Abstract Reasoning

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*All factors were extracted which contributed three percent or more of the variance.

Table A-1

Varimax Rotated Factor Loadings of the Pre-Test and Post-Test Batteries
Grade 8 Males (N=567)

		Factors					
	Variables	I	II	III	IV	V	VI
	Pre-Tests						
1	Abstract Reasoning	.20	.19	.21	.12	.14	-.78
2	Mechanical Reasoning	.57	.22	.10	.33	.19	-.40
3	Arithmetic Reasoning	.19	-.21	.37	.53	.37	-.21
4	Visual'n in 2 Dimens.	.25	.31	.08	.75	.04	-.10
5	Visual'n in 3 Dimens.	.24	.74	.13	.07	.12	-.14
6	Reading Comprehension	.25	-.03	.69	.28	.23	-.24
	Information:						
7	Vocabulary	.50	.01	.56	.27	.15	-.23
8	Math	.21	.08	.19	.06	.81	-.18
9	Physical Sciences	.56	.04	.49	.17	.25	-.20
10	Biological Sciences	.44	.11	.57	-.02	.15	-.16
11	Aeronautics & Space	.60	.13	.34	.02	.26	-.07
12	Elec'y & Electronics	.83	.07	.19	.19	.11	-.09
13	Mechanics	.70	.09	.37	.11	.09	-.10
	Post-Tests						
1	Abstract Reasoning	.00	.46	.32	.07	.06	-.65
2	Mechanical Reasoning	.43	.40	.25	.25	.11	-.44
3	Arithmetic Reasoning	.23	.10	.48	.29	.43	-.26
4	Visual'n in 2 Dimens.	-.03	.61	.18	.57	.02	-.08
5	Visual'n in 3 Dimens.	.10	.80	.03	.07	.06	-.18
6	Reading Comprehension	.23	.16	-.78	.15	.19	-.17
	Information:						
7	Vocabulary	.43	.12	.72	.21	.13	-.17
8	Math	.28	.17	.38	.07	.67	.03
9	Physical Sciences	.47	.09	.63	.10	.23	-.17
10	Biological Sciences	.29	.17	.77	-.01	.14	-.09
11	Aeronautics & Space	.52	.20	.44	.04	.23	-.06
12	Elec'y & Electronics	.68	.07	.43	.10	.15	-.07
13	Mechanics	.56	.20	.54	.01	.12	-.03

Factor Definitions* for Table A-2

Grade 9 - Male

I. Verbal-quantitative academic

II. Three-dimension Spatial Visualization

III. Technical Information

IV. Two-dimension Spatial Visualization

V. Biology

---

*All factors were extracted which contributed three percent or more of the variance.

Table A-2

Varimax Rotated Factor Loadings of the Pre-Test and Post-Test Batteries
Grade 9 Males (N=582)

	Variables	Factors I	 II	 III	 IV	 V
	Pre-Tests					
1	Abstract Reasoning	.46	.51	.04	.33	-.19
2	Mechanical Reasoning	.16	.56	.37	.15	-.47
3	Arithmetic Reasoning	.69	.25	.22	-.03	-.20
4	Visual'n in 2 Dimens.	.09	.26	.12	.78	-.12
5	Visual'n in 3 Dimens.	.13	.80	.11	.15	-.08
6	Reading Comprehension	.68	.06	.29	.17	-.44
	Information:					
7	Vocabulary	.57	.05	.51	.18	-.34
8	Math	.70	.15	.27	.07	-.14
9	Physical Sciences	.56	.18	.50	.17	-.31
10	Biological Sciences	.33	.10	.27	.10	-.74
11	Aeronautics & Space	.32	.21	.50	.03	-.46
12	Elec'y & Electronics	.22	.08	.80	.15	-.13
13	Mechanics	.29	.24	.72	.08	-.18
	Post-Tests					
1	Abstract Reasoning	.43	.41	.05	.43	-.14
2	Mechanical Reasoning	.24	.62	.30	.23	-.38
3	Arithmetic Reasoning	.73	.27	.22	.06	-.14
4	Visual'n in 2 Dimens.	.10	.27	.17	.81	-.07
5	Visual'n in 3 Dimens.	.14	.74	.19	.28	.07
6	Reading Comprehension	.69	.08	.30	.17	-.41
	Information:					
7	Vocabulary	.62	.08	.46	.19	-.33
8	Math	.74	.18	.31	.13	-.05
9	Physical Sciences	.55	.13	.53	.20	-.31
10	Biological Sciences	.38	.12	.37	.17	-.61
11	Aeronautics & Space	.38	.20	.46	.04	-.44
12	Elec'y & Electronics	.30	.17	.78	.06	-.20
13	Mechanics	.36	.21	.63	.14	-.24

Factor Definitions* for Table A-3

Grade 8 - Female

I. Verbal

II. Non-verbal Reasoning

III. Aero-space Information

IV. Information Re-test

V. Mechanical Reasoning Re-test

VI. Two-dimension Visualization Re-test

VII. Two-dimension Visualization and Mechanical Reasoning Pre-test

VIII. Mathematics Information Pre-test

IX. Electrical Information Re-test

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*All factors were extracted which contributed three percent or more of the variance.

Table A-3

Varimax Rotated Factor Loadings of the Pre-Test and Post-Test Batteries

Grade 8 Females (N=100)

		Factors								
	Variables	I	II	III	IV	V	VI	VII	VIII	IX
	Pre-Tests									
1	Abstract Reasoning	.01	.77	.14	-.25	.08	.09	-.11	.01	.05
2	Mechanical Reasoning	.24	.05	.02	-.16	.48	-.01	-.64	.06	.21
3	Arithmetic Reasoning	.63	.22	-.04	-.06	.10	.24	-.30	.26	.11
4	Visual'n in 2 Dimens.	.08	.38	.23	-.14	-.07	-.28	-.65	.09	-.11
5	Visual'n in 3 Dimens.	.17	.76	.13	-.03	.09	-.08	.15	.18	-.02
6	Reading Comprehension	.58	.35	.28	-.23	-.06	-.06	-.16	.18	.34
	Information:									
7	Vocabulary	.80	.19	.10	-.14	.05	-.19	.06	-.00	-.02
8	Math	.21	.18	.11	-.20	-.08	-.04	-.11	.83	.16
9	Physical Sciences	.61	.06	.22	-.11	.11	-.08	-.15	.34	.19
10	Biological Sciences	.69	-.04	.21	-.31	.08	.04	-.07	.03	.16
11	Aeronautics & Space	.18	.14	.73	.04	-.11	.12	-.27	.30	.17
12	Elec'y & Electronics	.45	-.11	.36	-.17	.26	-.11	.14	.53	-.07
13	Mechanics	.57	-.02	-.08	-.41	.12	-.19	-.22	.36	-.04
	Post-Tests									
1	Abstract Reasoning	.18	.73	.01	-.10	.09	-.18	-.17	-.03	.10
2	Mechanical Reasoning	.06	.31	.02	-.08	.87	-.05	-.07	-.01	-.00
3	Arithmetic Reasoning	.66	.33	-.01	-.15	-.01	.24	.02	.26	.15
4	Visual'n in 2 Dimens.	.00	.28	.04	-.05	.04	-.87	-.12	.07	.11
5	Visual'n in 3 Dimens.	.16	.64	.07	-.02	.16	-.30	-.25	.03	-.05
6	Reading Comprehension	.46	.39	.13	-.27	.09	-.30	-.01	.12	.47
	Information:									
7	Vocabulary	.40	.18	.26	-.62	.04	-.08	-.22	.07	.14
8	Math	.22	.12	.15	-.74	.20	-.11	.02	.16	.23
9	Physical Sciences	.55	.12	.30	-.25	.04	-.23	-.00	-.01	.50
10	Biological Sciences	.55	.16	.25	-.38	-.07	.01	-.19	-.04	.24
11	Aeronautics & Space	.19	.19	.77	-.19	.10	-.14	.03	-.01	.10
12	Elec'y & Electronics	.17	-.05	.12	-.24	.02	-.02	-.04	.12	.83
13	Mechanics	.29	.20	-.05	-.70	-.03	.07	-.09	.14	.16

Factor Definitions* for Table A-4

Grade 9 - Female

I. Mathematics Information
II. Spatial Visualization
III. Mechanical Information
IV. Biology
V. Electrical Information
VI. Mechanical Reasoning
VII. Aero-space Retest
VIII. Verbal
IX. Arithmetic Reasoning Pretest
X. Aero-space Pretest

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*All factors were extracted which contributed three percent or more of the variance.

Table A-4

Varimax Rotated Factor Loadings of the Pre-Test and Post-Test Batteries Grade 9 Females (N=162)

		Factors									
	Variables	I	II	III	IV	V	VI	VII	VIII	IX	X
	Pre-Tests										
1	Abstract Reasoning	.17	.38	-.09	.05	.01	.07	-.03	-.64	-.31	.03
2	Mechanical Reasoning	.01	.11	.01	.15	.17	.86	.05	-.14	-.17	-.00
3	Arithmetic Reasoning	.26	.10	.14	.16	.12	.12	.12	-.28	-.77	.07
4	Visual'n in 2 Dimens.	-.05	.81	.10	.18	-.07	.10	.09	-.02	-.12	-.16
5	Visual'n in 3 Dimens.	-.02	.54	.00	-.02	.37	.20	-.09	-.32	-.10	.30
6	Reading Comprehension	.17	.16	.27	.16	.13	.19	-.00	-.72	-.25	.09
	Information:										
7	Vocabulary	.14	.02	.41	.30	-.03	.08	.27	-.60	.06	.03
8	Math	.74	.04	.27	.04	.13	-.03	.07	-.24	-.26	.03
9	Physical Sciences	.27	.22	-.07	.34	.31	.11	.16	-.39	-.14	.27
10	Biological Sciences	.11	.13	.12	.87	.02	.07	.05	-.17	-.20	.08
11	Aeronautics & Space	.08	-.06	.27	.19	.05	.02	.23	-.16	-.08	.78
12	Elec'y & Electronics	.08	-.01	.20	.11	.86	.16	.04	-.03	-.06	.04
13	Mechanics	-.00	.13	.80	.11	.09	.07	.02	-.15	-.19	.14
	Post-Tests										
1	Abstract Reasoning	.24	.69	.09	.03	.14	-.00	.02	-.41	.07	.00
2	Mechanical Reasoning	.20	.40	.26	.13	.01	.62	.03	-.27	.14	.09
3	Arithmetic Reasoning	.35	.22	.07	.07	-.10	.29	.09	-.48	-.30	.23
4	Visual'n in 2 Dimens.	.10	.79	.04	.15	.03	.14	.10	-.04	-.11	-.11
5	Visual'n in 3 Dimens.	.02	.72	.10	.02	-.03	.04	.04	-.23	.07	.27
6	Reading Comprehension	.22	.25	.28	.13	.07	.21	.01	-.68	-.13	.12
	Information:										
7	Vocabulary	.17	.14	.17	.29	.14	.06	.38	-.64	.08	.05
8	Math	.82	.06	.06	.20	.01	.12	.09	-.20	-.06	.03
9	Physical Sciences	.46	.20	-.04	.31	.38	-.03	.21	-.48	.04	.05
10	Biological Sciences	.18	.20	.14	.72	.18	.19	-.11	-.24	.05	.10
11	Aeronautics & Space	.12	.15	.08	-.05	.04	.07	.85	-.11	-.09	.21
12	Elec'y & Electronics	.14	-.02	.39	.12	.44	-.12	.44	-.30	-.12	-.30
13	Mechanics	.31	.14	.68	.07	.19	.07	.12	-.16	.09	.11

Table A-5

Correlations Between Pre-Test and Post-Test Batteries
Grade 8 Males (N=567)

			Pre-Tests													Post-Tests														
			1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean	S.D.
Pre-Tests	1	**Abstract Reasoning**		.444	.334	.379	.378	.411	.443	.331	.411	.370	.310	.331	.337	.562	.487	.392	.318	.310	.410	.432	.320	.426	.368	.360	.352	.318	6.799	2,929
	2	**Mech. Reasoning**	.444		.406	.440	.398	.444	.510	.366	.523	.424	.420	.522	.524	.377	.681	.490	.346	.327	.421	.525	.390	.494	.394	.457	.489	.478	7.808	3.595
	3	**Arith. Reasoning**	.334	.406		.315	.151	.537	.487	.360	.470	.335	.327	.380	.346	.203	.355	.548	.198	.072	.442	.519	.415	.474	.387	.350	.414	.359	4.728	2.613
	4	**Visual'n 2 Dimens.**	.379	.440	.315		.354	.351	.384	.235	.344	.278	.292	.374	.298	.324	.423	.323	.528	.299	.301	.369	.262	.319	.242	.330	.299	.226	9.891	5.594
	5	**Visual'n 3 Dimens.**	.378	.398	.151	.354		.261	.287	.218	.328	.312	.284	.318	.303	.396	.485	.328	.410	.569	.334	.355	.286	.314	.312	.316	.283	.331	6.190	2.607
	6	**Reading Comp.**	.411	.444	.537	.351	.261		.666	.464	.638	.551	.508	.443	.526	.358	.475	.598	.237	.156	.751	.704	.443	.616	.573	.488	.526	.515	17.332	8.124
	7	**Info. Vocabulary**	.443	.510	.487	.384	.287	.666		.413	.695	.594	.579	.597	.645	.361	.499	.577	.271	.192	.638	.742	.474	.626	.578	.517	.581	.578	7.903	3.873
	8	**Info. Math**	.331	.366	.360	.235	.218	.464	.413		.481	.404	.402	.329	.385	.280	.356	.462	.214	.148	.414	.396	.530	.429	.358	.369	.352	.362	4.675	2.473
	9	**Info. Phys. Sci.**	.411	.523	.470	.344	.328	.638	.695	.481		.618	.584	.617	.608	.325	.494	.540	.242	.181	.588	.666	.475	.684	.605	.553	.631	.558	6.247	3.384
	10	**Info. Biol. Sci.**	.370	.424	.335	.278	.312	.551	.594	.404	.618		.505	.525	.558	.327	.428	.460	.187	.165	.581	.617	.439	.590	.631	.519	.520	.497	4.160	2.294
	11	**Info. Aero. & Space**	.310	.420	.327	.292	.284	.508	.579	.402	.584	.505		.572	.534	.282	.411	.447	.162	.211	.519	.531	.423	.540	.460	.592	.529	.502	3.123	1.965
	12	**Info. Elec. & Elec.**	.331	.522	.380	.374	.318	.443	.597	.329	.617	.525	.572		.649	.234	.476	.444	.181	.202	.452	.573	.419	.549	.417	.499	.725	.554	5.556	3.430
	13	**Info. Mechanics**	.337	.524	.346	.298	.303	.526	.645	.385	.608	.558	.534	.649		.247	.488	.459	.222	.186	.528	.599	.408	.564	.515	.481	.582	.675	7.099	3.384
Post-Tests	1	**Abstract Reasoning**	.562	.377	.203	.324	.396	.358	.361	.280	.325	327	.282	.234	.247		.525	.398	.470	.445	.436	.405	.264	.356	.360	.304	.279	.323	8.150	2.856
	2	**Mech. Reasoning**	.487	.681	.355	.423	.485	.475	.499	.356	.494	.428	.411	.476	.488	.525		.513	.445	.428	.490	.577	.371	.539	.468	.464	.484	.505	9.328	3.773
	3	**Arith. Reasoning**	.392	.490	.548	.323	.328	.598	.577	.462	.540	.460	.447	.444	.459	.398	.513		.280	.256	.601	.598	.504	.564	.493	.434	.470	.494	5.321	2.779
	4	**Visual'n 2 Dimens.**	.318	.346	.198	.528	.410	.237	.271	.214	.242	.187	.162	.181	.222	.470	.445	.280		.448	.311	.292	.207	.223	.233	.212	.183	.245	14.808	5.853
	5	**Visual'n 3 Dimens.**	.310	.327	.072	.299	.569	.156	.192	.148	.181	.165	.211	.202	.186	.445	.428	.256	.448		.241	.221	.163	.188	.176	.203	.168	.207	7.448	2.935
	6	**Reading Comp.**	.410	.421	.442	.301	.334	.751	.638	.414	.588	.581	.519	.452	.528	.436	.490	.601	.311	.241		.738	.505	.653	.649	.524	.564	.584	19.208	9.162
	7	**Info. Vocabulary**	.432	.525	.519	.369	.355	.704	.742	.396	.666	.617	.531	.573	.599	.405	.577	.598	.292	.221	.738		.531	.733	.700	.603	.669	.675	8.559	4.028
	8	**Info. Math**	.320	.390	.415	.262	.286	.443	.474	.530	.475	.439	.423	.419	.408	.264	.371	.504	.207	.163	.505	.531		.543	.512	.475	.520	.483	5.452	3.153
	9	**Info. Phys. Sci.**	.426	.494	.474	.319	.314	.616	.626	.429	.684	.590	.540	.549	.564	.356	.539	.564	.223	.188	.653	.733	.543		.672	.602	.668	.635	6.638	3.545
	10	**Info. Biol. Sci.**	.368	.394	.387	.242	.312	.573	.578	.358	.605	.631	.460	.417	.515	.360	.468	.493	.233	.176	.649	.700	.512	.672		.542	.559	.592	4.534	2.314
	11	**Info. Aero. & Space**	.360	.457	.350	.330	.316	.488	.517	.369	.553	.519	.592	.499	.481	.304	.464	.434	.212	.203	.524	.603	.475	.602	.542		.560	.552	3.407	2.076
	12	**Info. Elec. & Elec.**	.352	.489	.414	.299	.283	.526	.581	.352	.631	.520	.529	.725	.582	.279	.484	.470	.183	.168	.564	.669	.520	.668	.559	.560		.639	6.266	3.686
	13	**Info. Mechanics**	.318	.478	.359	.226	.331	.515	.578	.362	.558	.497	.502	.554	.675	.323	.505	.494	.245	.207	.584	.675	.483	.635	.592	.552	.639		7.700	3.579

Table A-6

Correlations Between Pre-Test and Post-Test Batteries
Grade 9 Males (N=582)

			Pre-Tests													Post-Tests														
			1	2	3	4	5	6	7	8	9	10	11	12	13	1	.2	3	4	5	6	7	8	9	10	11	12	13	Mean	S.D.
Pre-Tests	1	Abstract Reasoning		.527	.440	.413	.469	.449	.433	.424	.488	.378	.336	.300	.390	.561	.573	.494	.433	.421	.481	.460	.478	.477	.401	.389	.339	.406	7.811	2.976
	2	Mech. Reasoning	.527		.471	.438	.490	.494	.508	.427	.528	.509	.494	.472	.526	.395	.736	.441	.374	.416	.473	.484	.419	.508	.522	.494	.551	.535	9.282	3.684
	3	Arith, Reasoning	.440	.471		.247	.276	.592	.566	.539	.567	.481	.447	.417	.470	.387	.475	.686	.207	.231	.574	.546	.547	.537	.478	.449	.460	.500	5.916	2.902
	4	Visual'n 2 Dimens.	.413	.438	.247		.392	.293	.294	.257	.309	.244	.237	.271	.275	.393	.417	.271	.570	.388	.270	.286	.282	.290	.293	.243	.227	.285	11.301	5.741
	5	Visual'n 3 Dimens.	.469	.490	.276	.392		.276	.273	.265	.360	.266	.279	.245	.316	.413	.505	.322	.374	.614	.277	.302	.310	.306	.303	.295	.274	.289	6.960	2.896
	6	Reading Comp.	.449	.494	.592	.293	.276		.728	.599	.694	.599	.571	.492	.506	.434	.481	.613	.284	.267	.840	.735	.592	.657	.602	.581	.558	.543	22.538	9.629
	7	Info. Vocabulary	.433	.508	.566	.294	.273	.728		.582	.720	.582	.607	.607	.636	.411	.503	.576	.299	.265	.714	.796	.581	.679	.621	.566	.613	.602	10.002	3.835
	8	Info. Math	.424	.427	.539	.257	.265	.599	.582		.613	.471	.494	.417	.447	.366	.429	.540	.239	.272	.573	.579	.666	.571	.498	.490	.461	.465	6.284	3.134
	9	Info. Phys. Sci.	.488	.528	.567	.309	.360	.694	.720	.613		.618	.605	.639	.582	.448	.533	.558	.324	.366	.688	.701	.618	.783	.615	.574	.627	.564	8.050	3.758
	10	Info. Biol. Sci.	.378	.509	.481	.244	.266	.599	.582	.471	.618		.559	.465	.483	.351	.471	.451	.258	.205	.595	.564	.454	.576	.662	.518	.488	.524	5.122	2.184
	11	Info. Aero. & Space	.336	.494	.447	.237	.279	.571	.607	.494	.605	.559		.542	.571	.351	.493	.476	.269	.317	.570	.570	.466	.572	.509	.684	.540	.514	3.900	2.229
	12	Info. Elec. & Elec.	.300	.472	.417	.271	.245	.492	.607	.417	.639	.465	.542		.591	.262	.442	.411	.286	.244	.500	.531	.418	.586	.470	.470	.732	.536	7.201	3.717
	13	Info. Mechanics	.390	.526	.470	.275	.316	.506	.636	.447	.582	.483	.571	.591		.353	.504	.479	.290	.304	.515	.598	.475	.569	.528	.532	.629	.748	8.675	3.396
Post-Tests	1	Abstract Reasoning	.561	.395	.387	.393	.413	.434	.411	.366	.448	.351	.351	.262	.353		.518	.421	.452	.464	.468	.468	.400	.438	.371	.358	.334	.398	9.510	2.680
	2	Mech. Reasoning	.573	.736	.475	.417	.505	.481	.503	.429	.533	.471	.493	.442	.504	.518		.503	.480	.521	.505	.498	.449	.547	.520	.496	.519	.519	10.892	3.963
	3	Arith. Reasoning	.494	.441	.686	.271	.322	.613	.576	.540	.558	.451	.476	.411	.479	.421	.503		.286	.299	.648	.597	.608	.568	.511	.485	.462	.547	6.766	3.345
	4	Visual'n 2 Dimens.	.433	.374	.207	.570	.374	.284	.299	.239	.324	.258	.269	.286	.290	.452	.480	.286		.456	.308	.302	.301	.363	.308	.279	.264	.335	16.479	5.300
	5	Visual'n 3 Dimens.	.421	.416	.231	.388	.614	.267	.265	.272	.366	.205	.317	.244	.304	.464	.521	.299	.456		.292	.294	.316	.350	.262	.287	.295	.305	8.716	2.984
	6	Reading Comp.	.481	.473	.574	.270	.277	.840	.714	.573	.688	.595	.570	.500	.515	.468	.505	.648	.308	.292		.723	.624	.702	.615	.611	.564	.549	25.325	10.418
	7	Info. Vocabulary	.460	.484	.546	.286	.302	.735	.796	.579	.701	.564	.570	.531	.598	.468	.498	.597	.302	.294	.723		.629	.735	.665	.602	.612	.655	10.995	3.989
	8	Info. Math	.478	.419	.547	.282	.310	.592	.581	.666	.618	.454	.466	.418	.475	.400	.449	.608	.301	.316	.624	.629		.638	.503	.541	.515	.508	7.615	3.805
	9	Info. Phys. Sci.	.477	.508	.537	.290	.306	.657	.679	.571	.783	.576	.572	.586	.569	.438	.547	.568	.363	.350	.702	.735	.638		.677	.622	.693	.620	9.301	3.776
	10	Info. Biol. Sci.	.401	.522	.478	.293	.303	.602	.621	.498	.615	.662	.509	.470	.528	.371	.520	.511	.308	.262	.615	.665	.503	.677		.555	.574	.590	5.414	2.283
	11	Info. Aero. & Space	.389	.494	.449	.243	.295	.581	.566	.490	.574	.518	.684	.470	.532	.358	.496	.485	.279	.287	.611	.602	.541	.622	.555		.593	.557	4.471	2.204
	12	Info. Elec. & Elec.	.339	.551	.460	.227	.274	.558	.613	.461	.627	.488	.540	.732	.629	.334	.519	.462	.264	.295	.564	.612	.515	.693	.574	.593		.618	8.464	4.022
	13	Info. Mechanics	.406	.535	.500	.285	.289	.543	.602	.465	.564	.524	.514	.536	.748	.398	.519	.547	.335	.305	.549	.655	.508	.620	.590	.557	.618		10.137	3.633

Table A-7

Correlations Between Pre-Test and Post-Test Batteries
Grade 8 Females (N=100)

		Pre-Tests													Post-Tests														
		1	2	3	4	5	6	7	8	9	10	1	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean	S.D.
Pre-Tests	1 Abstract Reasoning		.259	.188	.329	.468	.349	.301	.251	.176	.092	.253	.052	.179	.584	.277	.244	.172	.500	.388	.298	.263	.252	.282	.273	.106	.307	4.292	2.252
	2 Mech. Reasoning	.259		.490	.330	.097	.393	.274	,224	.377	.289	.202	.215	.361	.261	.370	.228	.186	.260	.323	.357	.360	.295	.326	.203	.231	.289	4.500	2.432
	3 Arith. Reasoning	.188	.490		.253	.269	.535	.441	.405	.443	.434	.290	.340	.462	.249	.212	.617	.032	.245	.416	.368	.285	.396	.456	.247	.210	.454	3.979	2.624
	4 Visual'n 2 Dimens.	.329	.330	.253		.328	.368	.168	.279	.244	.168	.299	.102	.257	.418	.205	.196	.370	.436	.294	.395	.227	.245	.275	.279	.061	.158	5.615	3.489
	5 Visual'n 3 Dimens.	.468	.097	.269	.328		.450	.270	.284	.266	.207	.218	.141	.098	.448	.311	.346	.308	.489	.393	.235	.270	.226	.249	.249	.021	.226	5.073	2.168
	6 Reading Comp.	.349	.393	.535	.368	.450		.584	.490	.589	.541	.464	.368	.505	.418	.143	.558	.214	.347	.689	.608	.465	.647	.572	.504	.442	.499	13.469	6.241
	7 Info. Vocabulary	.301	.274	.441	.168	.270	.584		.302	.506	.513	.192	.412	.547	.314	.150	.508	.195	.270	.502	.464	.354	.493	.481	.351	.232	.302	5.042	2.513
	8 Info. Math	.251	.224	.405	.279	.284	.490	.302		.440	.299	.397	.476	.494	.212	.050	.432	.165	.168	.431	.417	.355	.294	.312	.247	.305	.300	4.188	2.084
	9 Info. Phys. Sci.	.176	.377	.443	.244	.266	.589	.506	.440		.538	.445	.505	.461	.204	.159	.524	.178	.262	.461	.494	.431	.562	.464	.260	.320	.397	4.125	2.192
	10 Info. Biol. Sci.	.092	.289	.434	.168	.207	.541	.513	.299	.538		.356	.444	.506	.196	.153	.441	.012	.116	.482	.575	.413	.552	.528	.251	.379	.426	3.010	1.803
	11 Info. Aero. & Space	.253	.202	.290	.299	.218	.464	.192	.397	.445	.356		.354	.225	.186	.014	.231	.060	.223	.339	.345	.189	.360	.364	.478	.252	.182	2.083	1.456
	12 Info. Elec. & Elec.	.052	.215	.340	.102	.141	.368	.412	.476	.505	.444	.354		.454	.126	.151	.356	.074	.143	.334	.348	.356	.394	.361	.347	.223	.277	3.438	2.136
	13 Info. Mechanics	.179	.361	.462	.257	.098	.505	.547	.494	.461	.506	.225	.454		.211	.222	.418	.179	.227	.479	.493	.438	.414	.456	.180	.255	.462	4.188	2.268
Post-Tests	1 Abstract Reasoning	.584	.261	.249	.418	.448	.418	.314	.212	.204	.196	.186	.126	.211		.332	.325	.370	.516	.517	.379	.206	.263	.286	.228	.120	.258	6.448	2.813
	2 Mech. Reasoning	.277	.370	.212	.205	.311	.143	.150	.050	.159	.153	.014	.151	.222	.332		.131	.165	.346	.287	.232	.240	.143	.098	.175	.044	.104	5.208	2.161
	3 Arith. Reasoning	.244	.228	.617	.196	.346	.558	.508	.432	.524	.441	.231	.356	.418	.325	.131		-.037	.221	.472	.466	.433	.448	.467	.260	.270	.351	4.385	2.653
	4 Visual'n 2 Dimens.	.172	.186	.032	.370	.308	.214	.195	.165	.178	.012	.060	.074	.179	.370	.165	-.037		.422	.417	.186	.231	.266	.131	.270	.094	.132	10.448	5.845
	5 Visual'n 3 Dimens.	.500	.260	.245	.436	.489	.347	.270	.168	.262	.116	.223	.143	.227	.516	.346	.221	.422		.346	.306	.207	.264	.264	.194	.058	.199	6.250	2.563
	6 Reading Comp.	.388	.323	.416	.294	.393	.689	.502	.431	.461	.482	.339	.334	.479	.517	.287	.472	.417	.346		.567	.497	.719	.523	.404	.445	.472	15.781	7.106
	7 Info. Vocabulary	.298	.357	.368	.395	.235	.608	.464	.417	.494	.575	.345	.348	.493	.379	.232	.466	.186	.306	.567		.627	.532	.568	.397	.389	.496	6.052	3.259
	8 Info. Math	.263	.360	.285	.227	.270	.465	.354	.355	.431	.413	.189	.356	.438	.206	.240	.433	.231	.207	.497	.627		.530	.490	.358	.417	.523	4.594	2.495
	9 Info. Phys. Sci.	.252	.295	.396	.245	.226	.647	.493	.294	.562	.552	.360	.394	.414	.263	.143	.448	.266	.264	.719	.532	.530		.557	.454	.515	.425	4.333	2.937
	10 Info. Biol. Sci.	.282	.326	.456	.275	.249	.572	.481	.312	.464	.528	.364	.361	.456	.286	.098	.467	.131	.264	.523	.568	.490	.557		.359	.423	.426	3.344	2.330
	11 Info. Aero. & Space	.273	.203	.247	.279	.249	.504	.351	.247	.260	.251	.478	.347	.180	.228	.175	.260	.270	.194	.404	.397	.358	.454	.359		.246	.234	2.271	1.599
	12 Info. Elec. & Elec.	.106	.231	.210	.061	.021	.442	.232	.305	.320	.379	.252	.223	.255	.120	.044	.270	.094	.058	.445	.389	.417	.515	.423	.246		.311	4.438	2.025
	13 Info. Mechanics	.307	.289	.454	.158	.226	.499	.302	.300	.397	.426	.182	.277	.462	.258	.104	.351	,132	.199	.472	.496	.523	.425	.426	.234	.311		4.865	2.465

Table A-8

Correlations Between Pre-Test and Post-Test Batteries
Grade 9 Females (N=162)

		Pre-Tests													Post-Tests													Mean	S.D.
		1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13		
Pre-Tests	1 Abstract Reasoning		.284	.450	.331	.410	.596	.337	.379	.424	.305	.176	.076	.151	.586	.385	.449	.346	.388	.510	.440	.329	.400	.326	.195	.203	.176	5.914	2.713
	2 Mech. Reasoning	.284		.326	.217	.314	.361	.226	.134	.314	.270	.129	.276	.186	.210	.493	.330	.243	.198	.305	.245	.192	.207	.314	.113	.083	.166	5.568	2.316
	3 Arith. Reasoning	.450	.326		.179	.319	.524	.346	.470	.414	.390	.267	.233	.284	.249	.241	.500	.242	.185	.461	.358	.401	.361	.286	.247	.350	.301	4.340	2.249
	4 Visual'n 2 Dimens.	.331	.217	.179		.388	.224	.191	.094	.245	.275	-.038	.026	.197	.522	.396	.242	.602	.490	.294	.196	.085	.212	.221	.142	.067	.126	7.352	4.451
	5 Visual'n 3 Dimens.	.410	.314	.319	.388		.434	.217	.181	.344	.186	.166	.262	.237	.450	.423	.382	.369	.496	.393	.360	.175	.361	.372	.188	.130	.222	5.679	2.302
	6 Reading Comp.	.596	.361	.524	.224	.434		.559	.448	.515	.404	.315	.273	.420	.452	.442	.531	.312	.316	.813	.570	.433	.498	.477	.268	.377	.423	18.605	8.228
	7 Info. Vocabulary	.337	.226	.346	.191	.217	.559		.425	.402	.419	.353	.194	.418	.348	.386	.409	.127	.269	.539	.611	.354	.491	.362	.292	.418	.437	6.938	2.637
	8 Info. Math	.379	.134	.470	.094	.181	.448	.425		.412	.267	.243	.245	.340	.324	.283	.431	.132	.129	.407	.392	.588	.503	.263	.243	.393	.390	4.815	2.661
	9 Info. Phys. Sci.	.424	.314	.414	.245	.344	.515	.402	.412		.416	.338	.290	.260	.403	.384	.470	.317	.272	.474	.487	.331	.653	.427	.258	.264	.286	5.191	2.622
	10 Info. Biol. Sci.	.305	.270	.390	.275	.186	.404	.419	.267	.416		.289	.212	.283	.238	.306	.328	.251	.205	.367	.430	.340	.442	.649	.123	.216	.236	4.012	1.962
	11 Info. Aero. & Space	.176	.129	.267	-.038	.166	.315	.353	.243	.338	.289		.194	.307	.155	.238	.292	.028	.172	.340	.326	.206	.214	.238	.308	.172	.319	2.580	1.368
	12 Info. Elec. & Elec.	.076	.276	.233	.026	.262	.273	.194	.245	.290	.212	.194		.258	.181	.185	.097	.087	.038	.258	.239	.164	.350	.255	.128	.410	.297	4.049	2.093
	13 Info. Mechanics	.151	.186	.284	.197	.237	.420	.418	.340	.260	.283	.307	.258		.220	.339	.290	.139	.236	.387	.316	.150	.210	.254	.200	.352	.486	5.148	2.368
Post-Tests	1 Abstract Reasoning	.586	.210	.249	.522	.450	.452	.348	.324	.403	.238	.155	.181	.220		.454	.376	.577	.517	.516	.448	.313	.456	.343	.208	.232	.335	7.747	2.780
	2 Mech. Reasoning	.385	.493	.241	.396	.423	.442	.386	.283	.384	.306	.238	.185	.339	.454		.435	.423	.398	.524	.396	.303	.330	.419	.194	.178	.352	6.556	2.833
	3 Arith. Reasoning	.449	.330	.500	.242	.382	.531	.409	.431	.470	.328	.292	.097	.290	.376	.435		.334	.313	.630	.484	.421	.469	.315	.258	.185	.290	5.012	2.780
	4 Visual'n 2 Dimens.	.346	.243	.242	.602	.369	.312	.127	.132	.317	.251	.028	.087	.139	.577	.423	.334		.487	.390	.249	.180	.274	.308	.172	.154	.203	12.944	6.005
	5 Visual'n 3 Dimens.	.388	.198	.185	.490	.496	.316	.269	.129	.272	.205	.172	.038	.236	.517	.398	.313	.487		.368	.336	.185	.277	.246	.199	.057	.212	7.111	2.844
	6 Reading Comp.	.510	.305	.461	.294	.393	.813	.539	.407	.474	.367	.340	.258	.387	.516	.524	.630	.390	.368		.553	.421	.554	.447	.267	.327	.433	20.049	9.288
	7 Info. Vocabulary	.440	.245	.358	.196	.360	.570	.611	.392	.487	.430	.326	.239	.316	.448	.396	.484	.249	.336	.553		.416	.570	.434	.382	.495	.413	7.994	3.212
	8 Info. Math	.329	.192	.401	.085	.175	.433	.354	.588	.331	.340	.206	.164	.150	.313	.303	.421	.180	.185	.421	.416		.498	.381	.238	.274	.318	5.877	2.568
	9 Info. Phys. Sci.	.400	.207	.361	.212	.361	.498	.491	.503	.653	.442	.214	.350	.210	.456	.330	.469	.274	.277	.554	.570	.498		.415	.294	.437	.352	6.488	2.758
	10 Info. Biol. Sci.	.326	.314	.286	.221	.372	.477	.362	.263	.427	.649	.238	.255	.254	.343	.419	.315	.308	.246	.447	.434	.381	.415		.095	.246	.338	4.019	1.718
	11 Info. Aero. & Space	.195	.113	.247	.142	.188	.268	.292	.243	.258	.123	.308	.128	.200	.208	.194	.258	.172	.199	.267	.382	.238	.294	.095		.330	.275	2.920	1.572
	12 Info. Elec. & Elec.	.203	.083	.350	.067	.130	.377	.418	.393	.264	.216	.172	.410	.352	.232	.178	.185	.154	.057	.327	.495	.274	.437	.246	.330		.408	4.710	2.310
	13 Info. Mechanics	.176	.166	.301	.126	.222	.423	.437	.390	.286	.236	.319	.297	.486	.335	.352	.290	.203	.212	.433	.413	.318	.352	.338	.275	.408		6.025	2.588

Appendix B-1

VOCATIONAL TALENT EXERCISES

General Description

There are four Vocational Talent Exercise booklets, 8½" by 11" in size, containing a total of 30 exercises, to be presented by the teacher in 30 class periods. No special preparation is required for the teacher. It is recommended that the teacher go over the descriptive portion or directions of the exercises with the class, then allow them to do the drills, and then go over the drills with the class to reinforce the concepts taught and to correct mistakes.

As with the other materials developed for this project, the text is at the sixth-grade reading level, designed to train or develop the talents of junior high school students in the skills necessary for adequate comprehension of vocational and technical courses.

The answers to the problems are placed with the individual exercises in Part A. However, at the request of the teachers the answers have been placed in the back of Part B. In Parts C and D the answers are in separate booklets and were given only to the teachers. For many exercises short explanations are given along with the correct answer.

Part A - Exercises 1-6

General Description: a 40-page booklet. The answers are given with each exercise.

Exercise 1 - GETTING THE IDEA (Abstract Reasoning - Part 1): The text describes the task and gives examples of procedures for completing standard six-cell abstract reasoning items with five alternative choices, one of which is correct. Drill 1 contains four problems, followed by the answers to these problems with a short explanation. Drill 2 contains four more, with answers given in the same manner.

Exercise 2 - SEEING THINGS IN TWO DIMENSIONS (2-D Visualization - Part 1): The text explains the procedure for solving this type of exercise, which shows a stimulus figure in a box on the left followed by five figures as alternative choices in boxes to the right. One of the figures to the right is the same as the stimulus figure turned around in the plane of the page. One drill of ten problems is given with this exercise. The answers to the problems are given without explanation on the next page.

Exercise 3 - SEEING THINGS IN THREE DIMENSIONS (3-D Visualization - Part 1): The text explains the procedure for solving problems of the surface development type. The student is given several drill exercises to show how the figures are developed. One drill of ten problems is given with this exercise; the answers accompany the problems.

Exercise 4 - GETTING THE IDEA (Abstract Reasoning - Part 2): The text explains a new concept for the problems, with an example. A drill with six problems to demonstrate this concept follows. Then another concept is presented, with six more problems. Then a third concept is presented, with another six-problem drill. The answers are given to all three drills.

Exercise 5 - SEEING THINGS IN TWO DIMENSIONS (2-D Visualization - Part 2): The student is directed to review Exercise 2, particularly the instructions. Then he is given two drills of ten problems each. Answers are given without explanation.

Exercise 6 - SEEING THINGS IN THREE DIMENSIONS (3-D Visualization - Part 2): The student is instructed to review Exercise 3 before proceeding. Then he is given ten problems, the answers for which are given on the page following, without explanation.

Part B - Exercises 7-15

General Description: a 48-page booklet, with the answers in the back of the booklet.

Exercise 7 - TECHNICAL INFORMATION - Part 1: This consists of 24 questions of the multiple-choice type which ask questions on basic information about mechanics, aviation, electricity, and electronics. Each question has five choices. An explanation of the correct answer is given in the back of the booklet for the convenience of the teacher who is not expert in the subject-matter area.

Exercise 8 - GETTING THE IDEA (Abstract Reasoning - Part 3): The students are told to review the previous abstract reasoning exercises before proceeding with this one. Several new ideas are introduced into the exercises, which are still of the basic six-cell format. There are 18 problems in this exercise; the answers with explanations are given in the back of the booklet.

Exercise 9 - SEEING THINGS IN TWO DIMENSIONS (2-D Visualization - Part 3): Again the students are told to review the previous visualization in two dimension exercises before proceeding. There are three drills given, with ten problems in each drill. The answers are shown in the back of the booklet without explanation.

Exercise 10 - TECHNICAL INFORMATION EXERCISE - Part 2: Like Exercise 7, this one contains 24 multiple-choice questions with five options each about basic mechanics, aviation, electricity, and electronics. Short explanations are given with the correct answer in the back of the booklet.

Exercise 11 - SEEING THINGS IN THREE DIMENSIONS (Block Counting - Part 1): This type of test was not given in Project Talent. The task is similar to that of many tests used in screening for vocational placement. After the explanation of the task, three drills of 12 problems each are given. The answers are shown in the back of the booklet without explanation.

Exercise 12 - TECHNICAL INFORMATION EXERCISE - Part 3: Like Exercises 7 and 10, this one contains 24 questions of the multiple-choice type, which ask basic information about mechanics, aviation, electricity, and electronics. Short explanations are given with the correct answer in the back of the booklet.

Exercise 13 - GETTING THE IDEA (Abstract Reasoning - Part 4): This is a number series exercise, where the student must find the relationship between successive numbers in a series of five and then fill in the sixth to continue the series. There are two drills given, with 32 items in each drill. The answers are shown in the back of the booklet without explanation.

Exercise 14 - SEEING THINGS IN THREE DIMENSIONS (Block Counting - Part 2): After a brief explanation of the task the student is given three drills with 18 problems in each exercise. Answers are shown in the back of the booklet without explanation.

Exercise 15 - TECHNICAL INFORMATION EXERCISE - Part 4: This is identical to Exercises 7, 10, and 12, except that the questions are different.

Part C - Exercises 16-23

General Description: a 64-page booklet. The answers are contained in a separate booklet which was distributed to the teacher only.

Exercise 16 - GETTING THE IDEA (Abstract Reasoning - Part 5): This exercise is similar to Exercises 1, 4, and 8. There are three drills containing six problems each. The answers in the separate booklet are given without explanation.

Exercise 17 - TECHNICAL COMPREHENSION - Part 1: This exercise consists of four main subsections concerning the steam engine, the rotary pump, a simple series circuit, and a vacuum power cylinder. In each section a diagram is given with accompanying text explaining the operation of the device. Then four to six multiple-choice questions are asked about the diagram or the explanation. The answers given in the separate booklet are accompanied by a brief explanation for the benefit of teachers who are not expert in the field.

Exercise 18 - SEEING THINGS IN THREE DIMENSIONS (Brick Counting - Part 1): There are two different tasks in this exercise. The first one is to determine the number of bricks in the stack, and the other one is to determine how many bricks are touching any one particular brick. Two drills of 12 problems each are given for the first task, and two more drills of 18 problems each are given for the second task. No explanations are given with the answers.

Exercise 19 - TECHNICAL COMPREHENSION - Part 2: The format of this exercise is similar to that of Exercise 17. The devices used in the four subsections are the four-cylinder gasoline engine, the hand pump, a vacuum tube, and a coil-type gauge circuit. As with the previous exercise the diagram of the device is followed by a brief explanation and by four to six multiple-choice items based upon the diagram or the text. The answers in the separate booklet are accompanied by a brief explanation.

Exercise 20 - GETTING THE IDEA (Abstract Reasoning - Part 6): This is another number series exercise similar to Exercise 13. Two drills of 32 problems each are given. The answer is filled in by the student.

Exercise 21 - TECHNICAL COMPREHENSION - Part 3: The format for this exercise is similar to that of Exercises 16 and 19. The devices used are a two-cycle engine, a liquid cooling system for automobile engines, a simple direct-current motor, and a gear train. Brief explanations are given with the answers.

Exercise 22 - SEEING THINGS IN THREE DIMENSIONS (3-D Visualization - Part 3): This is a surface development exercise similar to Exercises 3 and 6. Three drills are given with six exercises each.

Exercise 23 - TECHNICAL COMPREHENSION - Part 4: This exercise is like Exercises 16, 19, and 21. The devices used are a four-cycle diesel engine, a gasoline engine fuel system, a simple door bell, and a simplified carburetor. The answers again are given with brief explanations.

Part D - Exercises 24-30

General Description: a 64-page booklet. As with Part C, the answers are contained in a separate booklet which was distributed only to the teachers.

Exercise 24 - TECHNICAL COMPREHENSION - Part 5: This exercise is like the four in Part C. The devices used are the simple impulse turbine, the centrifugal pump, the parallel circuit, and the treadle and crankshaft action. Short explanations are given with the answers in the separate booklet.

Exercise 25 - GETTING THE IDEA (Abstract Reasoning - Part 7): This is a six-cell-type exercise similar to Exercises 1, 4, 8, and 16. No new principles are introduced. There are three drills of six problems each. The answers in the separate booklet are given without explanation.

Exercise 26 - TECHNICAL COMPREHENSION - Part 6 : The devices used in this exercise are the ramjet engine, the jet pump, a telephone transmitter, and a jack.

Exercise 27 - SEEING THINGS IN THREE DIMENSIONS (Brick Counting - Part 2): The tasks in this exercise are exactly similar to those given in Exercise 18. As in the previous exercise, two exercises of 12 problems each are concerned with counting the number of bricks in each stack, and two drills of 18 problems each are concerned with finding how many bricks touch a designated brick.

Exercise 28 - TECHNICAL COMPREHENSION - Part 7: The devices used in this exercise are the piston, connecting rod, and crankshaft; the two-stroke-cycle diesel engine; the magnetic circuit breaker; and the gear train.

Exercise 29 - SEEING THINGS IN THREE DIMENSIONS (3-D Visualization - Part 4): This is a surface development exercise similar to Exercises 3, 6, and 22. There are three drills of six problems each.

Exercise 30 - TECHNICAL COMPREHENSION - Part 8: The devices used in this exercise are the external contracting brake, the plunger-type fuel pump, the four-pole A C generator, and the automobile fan belt assembly.

Appendix B-2

BASIC READERS

General Description

Particular attention was given to writing the readers to make them understandable and interesting to 8th graders who read at the 6th-grade level or below. They are profusely illustrated and expository in style. Every effort was made to include subject matter which would be familiar to 14- to 16-year-olds of low socioeconomic status. While much of the material is of particular interest to boys, there is also much that is of interest to girls as well.

The books are all printed on white or light buff paper. The text was typed double-space with wide margins. The length of the lines seldom exceeded five inches. Wherever possible simple words and short sentences were used.

It was planned that the readers be given to the students to retain in their possession to read on their own time. This would give them basic mechanical concepts and background information before they worked with the lab equipment and aptitude exercise booklets. It was found that some teachers preferred to keep the booklets in the classroom and check them out to the experimental students at appropriate times. But in all cases, the booklets were in the custody of only the teachers in charge of the specific experimental groups for the study, for use by those in the sample.

The concept of the role of the readers as part of the integrated curriculum for teaching basic vocational talents was envisioned as being much broader than narrow training in the specific skills measured by such tests as abstract reasoning, mechanical reasoning, and spatial visualization. It was planned to give students a broad background of the basic concepts, knowledge, and skills in basic mechanics and technology. In accomplishing this, the readers have two purposes. One is as a source of learning specific information in the area of mechanical concepts and comprehension, and the other to help give a broad background of basic knowledge and understanding in the field of technology. It is believed that students need to have a broad background of information on what the various skilled occupations do as part of their basic pre-vocational instruction that they need before initiation of specific job training in the 10th grade. Another collateral purpose is to help motivate them by using material that will have high interest value.

During the period of this contract an extensive study of the literature on formulas for determining readability level was made. It was concluded that there is no satisfactory scale or accepted scientific procedure which can establish the readability level of materials in advance of their writing. The formula-type criteria are useful as guides but are no substitute for the professional judgment of the authors. It is strongly believed, too, that the weaknesses of the formula approaches to this problem are particularly serious with the writing of materials in the mechanical and technological area. There seems to be a consensus that the content of the material is the predominant factor leading to its readability level, particularly in the mechanical and technological area.

Those staff members participating in the preparation of the readers were briefed on following the conventions of the readability formulas in terms of keeping paragraphs and sentences short, and avoiding the use of unusual words, etc. With the exception of technical terminology, the materials were all written at very easy level according to conventional readability criteria. It is strongly believed that the criterion of "unusual words" does not apply at all in the mechanical or technological area, since almost all of the words in that area are unusual as far as general written materials are concerned. It has been found that many of these words that may be unusual from the point of view of conventional word lists are not very unusual to most of the 8th-grade boys who are poor readers. If they don't know some of the words, they don't at all mind having them included. There is some evidence that they are challenged to want to know the words that they do not already know.

It is considered doubtful that any of the current word lists have much relevance to estimating the grade level of mechanical or technological material designed for use with educationally disadvantaged adolescents. These word lists are based on literary material that is almost completely devoid of technological content. This material is also heavily flavored with rural and middle-class culture. Clarence R. Stone's revision of the Dale List of 769 Easy Words (Spache,1966), for example, includes many words that may not be familiar to poor readers among urban disadvantaged youth. On the other hand, many words such as ignition, generator, hydraulic, lubrication, distributor, cylinder, transmission, differential, or carburetor were found to be easily acquired and understood by most disadvantaged 8th- and 9th-grade students.

It was decided, therefore, that the primary guide to determining the difficulty level of materials to be used would be to try materials out informally on groups of disadvantaged adolescents known to be at the 6th-grade level on paragraph comprehension tests. This was done with several in-school and out-of-school groups.

In preparing the occupational readers, efforts were made to keep the vocabulary as simple as possible. However, some words and material at higher than 6th-grade level in some instances were included to challenge the students to broaden their vocabularies. It was found that an occasional word the student does not know does not deter him if he is basically interested in the material and is able to understand most of it.

"Proof of the pudding" in regard to the materials being developed is whether the groups they are designed for like them and can profit from them and understand a reasonable amount of the content. Apparently this has been demonstrated in the studies that were conducted.

A brief description of the readers follows:

"TRANSPORTATION LONG AGO"

This is a 64-page, double-size booklet (11" by 17"), containing pictures and illustrations taken from early issues of the Scientific American. To many of the pages have been added simple text in primary type which explains the picture. The booklet gives a rather comprehensive picture of the early days of the automobile and airplane as well as other modes of transportation such as the airship, balloon, and train. Advertisements from the period 1899 to 1920 are also shown. This book was designed to arouse interest in technical and mechanical subjects.

An abbreviated outline of the various types of material follows:

Airplanes: Wright Brothers airplane at Kitty Hawk; auto-airplane race; early experimental planes, helicopters, and propellers; and famous American and European pilots

Airships: Balloons, dirigibles, and an air fleet of 1911

Ships: Sailing ship, yacht, and battleship

Automobiles: Steam automobile, electric automobiles, racing cars, touring cars, fire engines, early automobile nomenclature of parts, storage battery, and many advertisements for old cars

Engines: Locomotives from 1832 to 1910 and cross-sectional views of automobile engine parts

"TRANSPORTATION TODAY AND TOMORROW"

This is a 128-page booklet measuring 8½" by 11". The text is typed double-space with staggered paragraphs. It is profusely illustrated with pictures obtained from three main sources: the respective automobile manufacturers, the National Aerospace Education Council, and the U.S. Atomic Energy Commission. Full acknowledgment of the sources will be found in the booklet itself.

An abbreviated outline of the various types of materials follows:

1966 American Automobiles: Brief text accompanies many of the pictures of these automobiles, describing the unique features such as engine power and design, and body innovations. Text accompanies the Oldsmobile Toronado, Buick Riviera, Cadillac, Chrysler Imperial, American Motors Ambassador, Pontiac GTO, Chevrolets, Plymouth Barracuda, Dodge Dart, Ford Falcon, Ford Mustang, Lincoln Continental, Dodge Trucks, and Chevrolet Trucks. Pictures are given without text for 24 additional models.

Specifications for 1966 U.S. Automobiles: The specifications for 48 different models of U.S. automobiles are given. These specifications include length, wheel base, tire size, curb weight, horsepower, engine displacement, bore and stroke, compression ratio, and barrels in carburetor.

Foreign Automobiles: Because of interest shown in foreign cars by the students and teachers who used the materials, this section on foreign cars was added. The cars for which text is supplied include the Rolls-Royce, Volkswagen Fastback and Squareback, and Mercedes-Benz. Besides a list of the names of various makes of foreign cars by countries, pictures are shown of 23 other foreign 1965 cars with brief descriptive text and statistics about wheelbase, weight, length, height, displacement, cylinders, horsepower, and price.

Aircraft: Fourteen different types of aircraft and three types of helicopters are presented. Accompanying the picture of the aircraft is a recognition diagram, short text about the use of the plane, details about the specifications, and notes on the performance. The aircraft included are: Beechcraft D95A Travel Air, Boeing 707, Douglas A-4 Skyhawk Attack Bomber, F-27F Propjet Transport, Fairchild Hiller Turbo-Porter, Grumman E-2A Hawkeye and A-6A Intruder, B-58 Hustler, Hughes 300 Deluxe, Kaman UH-2A Seasprite, Lockheed YF-12A Advanced Interceptor, McDonnell Phantom II, Piper Aztec C and Apache 235, Republic F-105 Thunderchief, Sikorsky S-62, and North American X-15.

Rockets, Missiles, and Spacecraft: The section is not exhaustive of the complete inventory of rockets, missiles, and spacecraft, but was intended only to treat of the better known U.S. models. Text accompanies the pictures and deals with the major features and unique characteristics. Included are the following: Minuteman, Polaris/Poseidon, Titan, Nike X, Project Apollo, Project Gemini, Manned Orbital Laboratory, Telstar, Explorer, Surveyor, Ranger, Mariner Mars, Saturn, Titan, and Agena.

Nuclear Power: This section starts with a one-page description of nuclear power, then another page outlining in simple terms how atomic energy is released. Next is a description and a diagram of how a nuclear reactor drives a submarine, followed by pictures and text concerning three submarines, the N.S. Savannah, and a nuclear lighthouse.

Principles of Mechanics and Engineering: Interspersed with these pictures of new "hardware" are short discussions of various mechanical and engineering principles. Most of these apply to the subject matter of the particular section, and are introduced where the interest in this material should be highest. These subjects are: the gasoline engine, the diesel engine, how the gearshift works, the airplane, jet engines and rockets, and the discussions on nuclear power mentioned above.

Crossword Puzzles: Four crossword puzzles were devised by members of the staff utilizing names of cars or models of cars, and engine parts and terms. These crossword puzzles were interspersed through the text and the answers given at the end of the booklet.

"THE AUTOMOBILE"

This is a 96-page, 8½" by 11", booklet. Two of the three sections into which the book is divided deal with the Ford car, the first with the Model T and the second with the Model A. The third part of the book concerns old cars in general. Each part contains many illustrations. Some of these are cross-sectional views, others actual photographs, and others are line drawings. Almost every page has an illustration of some kind.

An abbreviated outline of each part follows:

Part A. The Model T Ford: After a short introduction about how the Ford became so popular, there are sections about lubrication, how the engine works, the transmission, the cooling system, the fuel system and carburetor, the electrical circuits, the ignition system, the auxiliary electrical circuits, the rear axle assembly, the spring suspension, and the steering wheel showing the throttle and spark.

Part B. The Model A Ford: A short description of the history of the Model A and its specifications are given followed by sections on such items as: instruments and control levers, how the engine works, piston and crankshaft, front view of the engine, the fuel system, dash adjustment and carburetor, water cooling system, lubrication system, transmission, electrical wiring system, rear axle assembly, springs and shock absorbers, brakes, and chassis.

Part C. Other Old Cars: This part concentrates on the ways other types of old cars performed the essential functions of an automobile. Many terms used today in automobiles are explained, and contrasts in types of equipment are shown. The subjects discussed in this section are: the ignition system, valve timing, the fuel system, pistons, the clutch, lubricating system, and cooling system.

"TOOLS AND BASIC MACHINES"

This is a 112-page 8½" x 11" booklet. Hand tool use and nomenclature are very essential parts of mechanics. The purpose of this booklet was to present the more common types of hand tools and basic machines. The section about power tools and tractors was added to increase interest and to demonstrate mechanical principles in use.

A brief outline of the major parts of this booklet follow:

Tools and Basic Machines: Most of the illustrations in this section are line drawings with the names of the parts indicated. Accompanying each picture is a short text about the uses of the hand tool. While the treatment is not exhaustive, most of the common hand tools are covered. The tools used in woodworking and metalworking are illustrated, as are several types of soldering irons and earthworking tools such as picks and shovels.

Power Tools: The main emphasis of this section is to show the various types of power hand tools such as drills and saws and to tell a little about the uses of each.

Fastening Devices: This section illustrates the various types of devices used in woodworking and metalworking. The illustrations show the various types of nails, wood and machine screws, bolts, nuts, washers, capscrews, studs, pins, and keys.

What is a Machine? This section is intended to discuss the various types of machines. The general principle is described in each case and illustrations of each given. The topics covered in this section are: friction, reducing friction, the inclined plane, wedge, screw, principles of the lever, three classes of levers, wheel and axle, gears, cams, and pulleys.

Tractors: This section is not exhaustive of all types of tractors. The principle criterion was diversity of types. There are pictures of both very large and very small tractors with a brief description of each, with a list of specifications supplied by the manufacturer. In addition, there is a section on tractor attachments showing a picture of an attachment with a brief description of just what it does. The versatility of farm equipment is stressed, with the object of illustrating just how the various mechanical principles discussed in the previous section are put to work.

"OCCUPATIONS FOR YOU - Part One"

This is a 168-page 8½" x 11" booklet. The principal source of the material used in this booklet was The Occupational Outlook Handbook issued by the U.S. Department of Labor. Material therein was augmented from various sources such as other Department of Labor and trade union publications. It was intended that each occupational brief should be in the same general format so that the reader could easily locate corresponding information in each brief. Arrangement is as follows:

Introduction: This explains the general arrangement of the material in the briefs and the terms used in them.

Building Trades: The occupations described in this section are bricklayer, carpenter, electrician, heavy equipment operator, painter and paperhanger, plumber and pipefitter, and sheet-metal worker.

Mechanics and Repairmen: The occupations in this section are air-conditioning and refrigeration mechanic, airplane mechanic, appliance serviceman, automobile mechanic, body and fender repairman, business machine serviceman, diesel mechanic, electronics technician, and television and radio serviceman.

Other Jobs: These occupations are Armed Forces enlisted man, baker, building custodian, butcher and meatcutter, cook and chef, draftsman, gasoline service attendant, machine-shop worker, printer, truckdriver, and welder.

Glossary: This is a brief list of terms used in training and testing which might be of interest to the reader. Many of the terms were used in the text.

What Will My Earnings Be? The principal purpose of this section is to explain the table of conversion of hourly wage to weekly wage and annual wage. This is because it was found that one of the principal mistakes made by students in the population intended for the main emphasis of this research was lack of realism. They had no idea how much the hourly rate was for an income level of, say, $10,000 per year.

Average Earnings of Workers in Various Occupations: The data from all the occupational briefs were assembled in a diagram showing on a vertical scale the relative earnings of the various occupations. These go all the way from gasoline service attendant at the lower end of the scale to heavy equipment operator at the upper end. These are based upon average weekly pay.

"OCCUPATIONS FOR YOU - Part Two"

This is a 168-page 8½" by 11" booklet. As with Part One the principal source of the material used was The Occupational Outlook Handbook issued by the U.S. Department of Labor. Additional information was added from a number of sources such as other Department of Labor and trade union publications. All briefs have the same general format so that the reader can easily locate corresponding information in each brief. Arrangement is as follows:

Introduction: This explains the general arrangement of the material in the briefs and the terms used.

Service Occupations: The occupations in this section are barber, cosmetologist, dry-cleaning worker, hospital attendant, practical nurse, and telephone operator.

Sales Occupations: The occupations included in this section are cashier, outdoor salesman, sales clerk, soda fountain attendant, and store clerk.

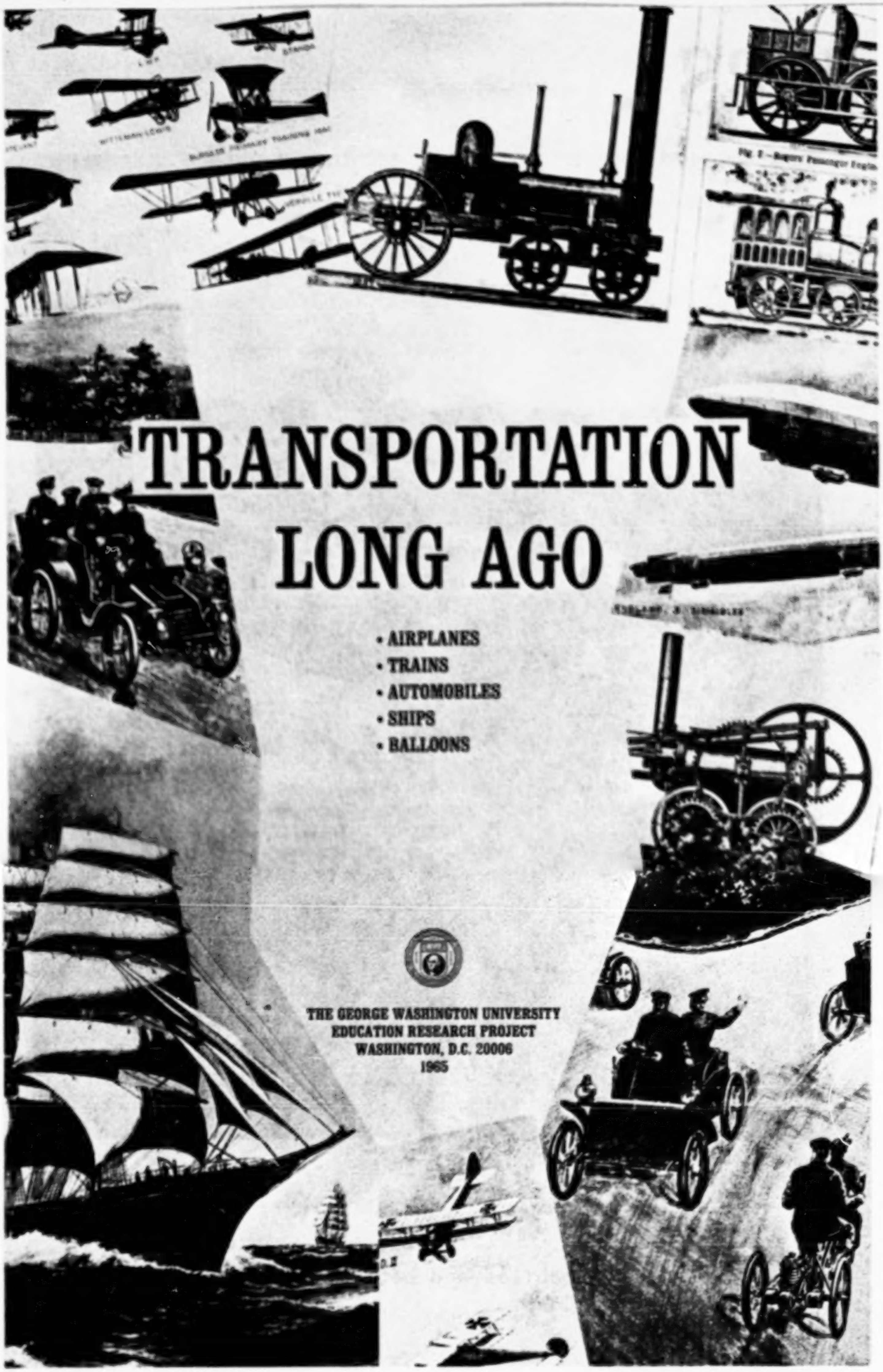
Clerical Occupations: These office occupations are for keypunch operator, secretary, and typist.

Other Occupations: This is a section containing eight different briefs that do not fall within the above categories. They are: commercial artist, factory floor assembler, laundry worker, mail carrier, policeman and policewoman, postal clerk, routeman, and shipping and receiving clerk.

Glossary: This is a brief list of terms used in training and testing which might be of interest to the reader. Many of the terms were used in the text. No attempt was made to include words that were unique to or characteristic of any one occupation.

What Will My Earnings Be? The principal purpose of this section is to explain the table of conversion of hourly wages to weekly wages and annual income. This was thought to be of interest to our population of readers, who characteristically had very little concept of how much annual income the various hourly rates represented. This section is the same as that given in Part One.

Average Earnings of Workers in Various Occupations: The average earnings from all the occupational briefs contained in this booklet were plotted in a diagram showing on a vertical scale the relative position of each occupation. These data were taken from figures of the U.S. Department of Labor.



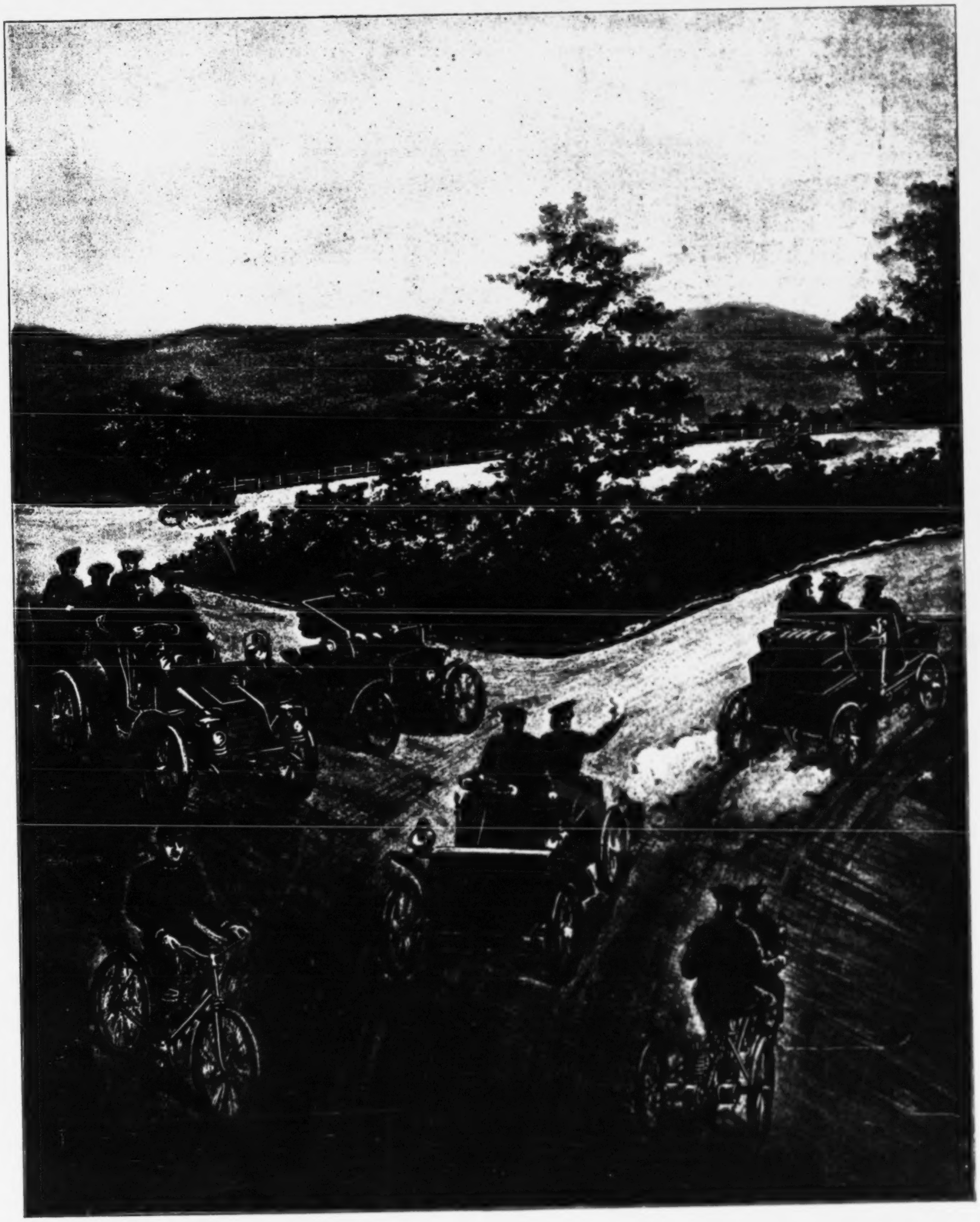
TRANSPORTATION
LONG AGO

- AIRPLANES
- TRAINS
- AUTOMOBILES
- SHIPS
- BALLOONS

THE GEORGE WASHINGTON UNIVERSITY
EDUCATION RESEARCH PROJECT
WASHINGTON, D.C. 20006
1965

Cover of "TRANSPORTATION LONG AGO"

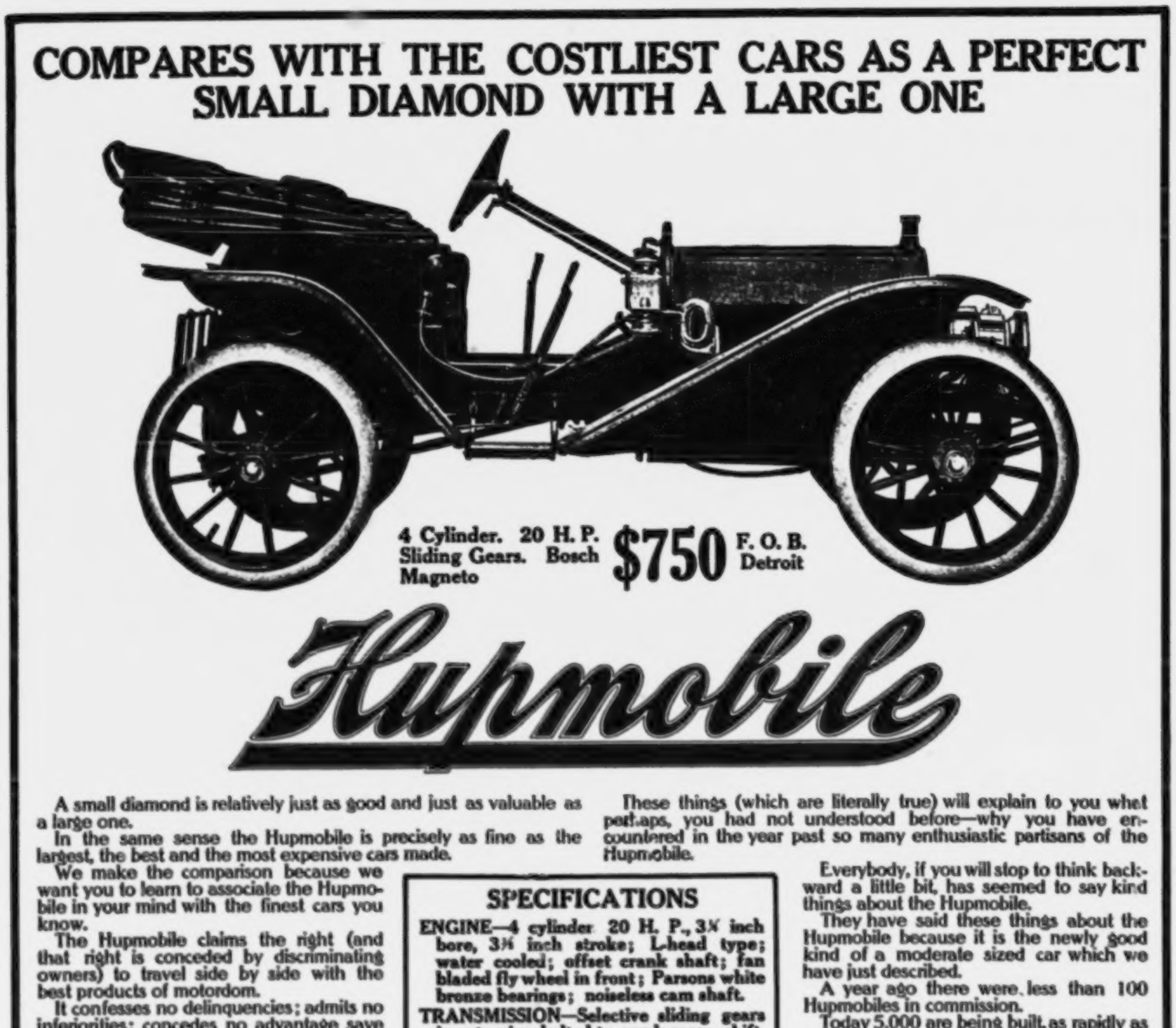
CARS



Some automobiles and motor bicycles in 1901

Sample page from "TRANSPORTATION LONG AGO"

ADVERTISEMENT



COMPARES WITH THE COSTLIEST CARS AS A PERFECT SMALL DIAMOND WITH A LARGE ONE

4 Cylinder. 20 H. P. Sliding Gears. Bosch Magneto **$750** F. O. B. Detroit

Hupmobile

A small diamond is relatively just as good and just as valuable as a large one.

In the same sense the Hupmobile is precisely as fine as the largest, the best and the most expensive cars made.

We make the comparison because we want you to learn to associate the Hupmobile in your mind with the finest cars you know.

The Hupmobile claims the right (and that right is conceded by discriminating owners) to travel side by side with the best products of motordom.

It confesses no delinquencies; admits no inferiorities; concedes no advantage save size and carrying capacity, to cars costing twice and thrice its price.

Observe the personnel of its ownership in your own city.

Note that the majority of men who drive a Hupmobile are the men who know good cars—whose private garage, perhaps, houses several fine cars of other types.

The Hupmobile was built to fill a particular need—to supply a special want—to furnish a type of car that was lacking.

Its creators could see no reason why a car carrying two passengers should not be just as good—just as sound and just as trustworthy—as the best big car built.

Every part that contributes to power and speed and staunchness in the Hupmobile is precisely as good and fine as the same part in the best big car.

The two are mates in quality.

The Hupmobile will go anywhere that the big car will go; climb any hill the big car will climb; and do anything the big car will do except that it will not carry the same number of passengers.

When you buy the ordinary car of moderate price, you say to yourself:—

"I am getting just the sort of a car indicated by the price—a moderately good car."

When you buy a Hupmobile, on the contrary, you buy a quality and a degree of excellence with which the price has nothing to do.

If the Hupmobile were any bigger, it could not be made as good without increasing the price.

SPECIFICATIONS

ENGINE—4 cylinder 20 H. P., 3¾ inch bore, 3¼ inch stroke; L-head type; water cooled; offset crank shaft; fan bladed fly wheel in front; Parsons white bronze bearings; noiseless cam shaft.

TRANSMISSION—Selective sliding gears in extension bolted to crank case; shifting without noise.

CLUTCH—Multiple disc type; self-adjusting; enclosed in gear case; running in oil.

REAR AXLE—Shaft drive; Hyatt roller and New Departure bearings; shaft and universal joint enclosed and lubricated by oil from crank case through transmission.

BRAKES—Two foot and two emergency (internal expanding) lined with Thermoid on rear hubs.

IGNITION—Bosch high tension magneto, doing away with spark coil, batteries and connecting wires.

TIRES—30 x 3 inches.

WHEEL BASE—86 inches.

TREAD—56 inches.

SPRINGS—Semi-elliptical front, patented cross spring rear.

EQUIPMENT—Two side and tail oil lamps, dragon horn, tools, repair kit, pump.

WEIGHT—1100 pounds regular equipment.

These things (which are literally true) will explain to you what perhaps, you had not understood before—why you have encountered in the year past so many enthusiastic partisans of the Hupmobile.

Everybody, if you will stop to think backward a little bit, has seemed to say kind things about the Hupmobile.

They have said these things about the Hupmobile because it is the newly good kind of a moderate sized car which we have just described.

A year ago there were less than 100 Hupmobiles in commission.

Today 5,000 are being built, as rapidly as excellence of workmanship with the finest materials will permit of hurry—to satisfy a demand which sprang up in incredible volume before the first hundred cars were completed.

Of course, you want to know all about a car which has been favored with the warmest approval ever extended by the American motor-buying public to any motor car.

Even if you own a car to which you are strongly attached, you would like to have placed before you all the information which will shed light upon a condition so unprecedented as the Hupmobile has created.

And if you are wavering in your choice of a car, your desire to know is even stronger.

Sign and send the coupon.

It will bring you not only the Hupmobile literature, picturing and describing the 1910 Hupmobile in every detail.

It will bring in addition, the name and address of the Hupmobile dealer in your home, or the one nearest you.

We will put you in direct touch with the car, so that you can ride in it and satisfy yourself as to the literal truth of every statement we have made.

Clip the coupon and send it now.

As an object lesson, three Hupmobiles were driven through the biting winter weather and deep snows, from Detroit to New York for the Grand Central Palace Show.

HUPP MOTOR CAR COMPANY

DEPT. Q. DETROIT, MICH.

Hupp Motor Car Co.
Dept. Q
DETROIT, MICH.

Send 1910 Hupmobile literature and name and address of Hupmobile dealer.

Name ....

Address ....

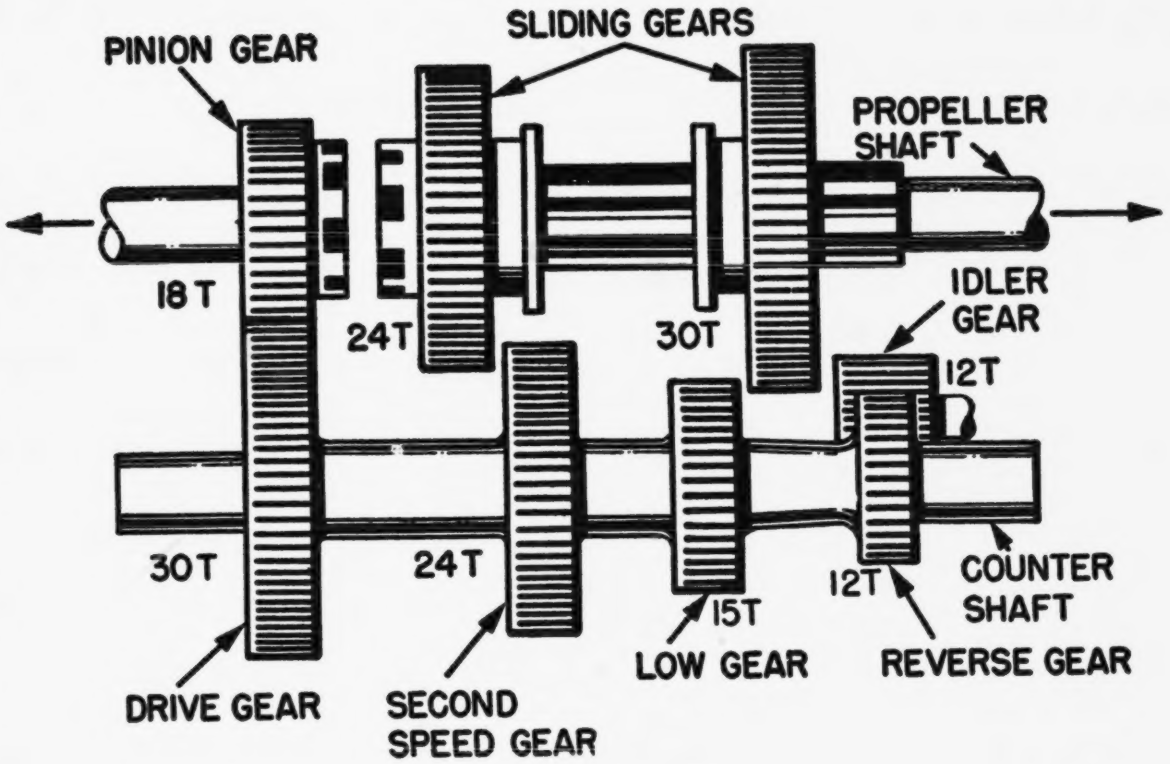
Sample page from "TRANSPORTATION LONG AGO"

TRANSPORTATION TODAY AND TOMORROW

THE GEORGE WASHINGTON UNIVERSITY
SCHOOL OF EDUCATION
EDUCATION RESEARCH PROJECT
WASHINGTON, D.C. 20006
1966

Cover of "TRANSPORTATION TODAY AND TOMORROW"

THE GEARSHIFT


PINION GEAR
SLIDING GEARS
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IDLER GEAR
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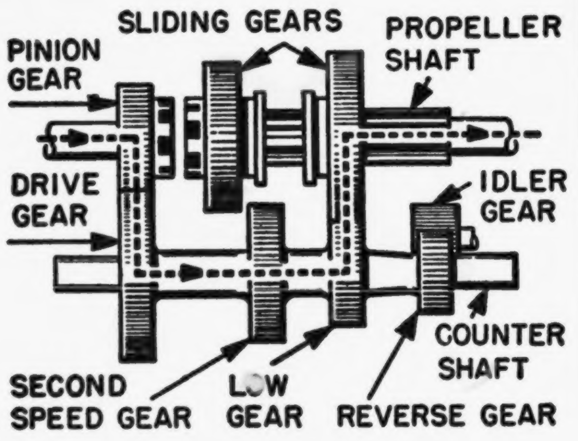
15T
12T
COUNTER SHAFT
DRIVE GEAR
SECOND SPEED GEAR
LOW GEAR
REVERSE GEAR

GEARS IN NEUTRAL


PINION GEAR
SLIDING GEARS
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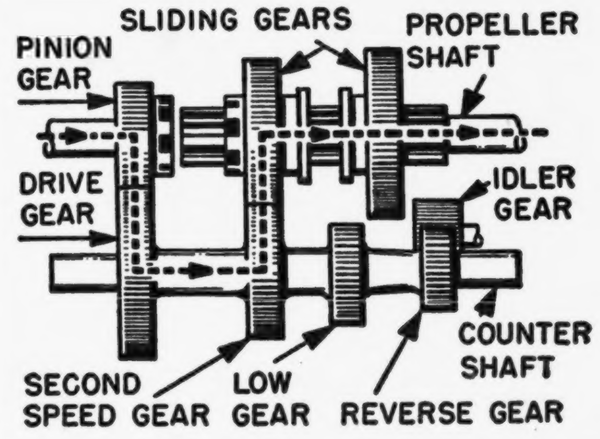
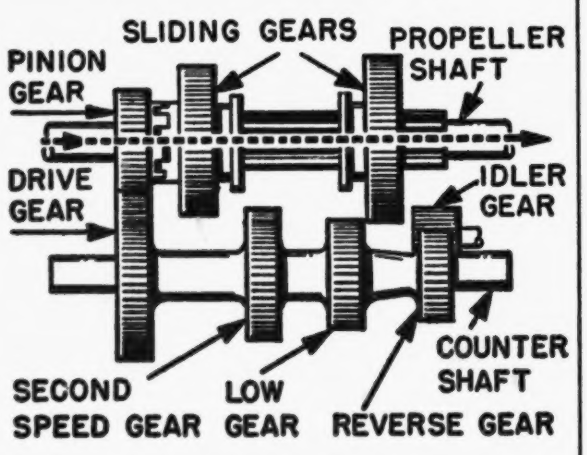
IDLER GEAR
COUNTER SHAFT
SECOND SPEED GEAR
LOW GEAR
REVERSE GEAR

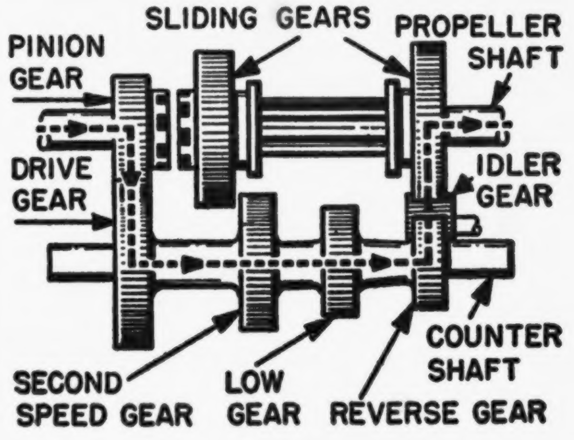
FIRST OR LOW SPEED


PINION GEAR
SLIDING GEARS
PROPELLER SHAFT
DRIVE GEAR
IDLER GEAR
COUNTER SHAFT
SECOND SPEED GEAR
LOW GEAR
REVERSE GEAR

SECOND, OR INTERMEDIATE SPEED


PINION GEAR
SLIDING GEARS
PROPELLER SHAFT
DRIVE GEAR
IDLER GEAR
COUNTER SHAFT
SECOND SPEED GEAR
LOW GEAR
REVERSE GEAR

HIGH GEAR


PINION GEAR
SLIDING GEARS
PROPELLER SHAFT
DRIVE GEAR
IDLER GEAR
COUNTER SHAFT
SECOND SPEED GEAR
LOW GEAR
REVERSE GEAR

REVERSE

Sample page from "TRANSPORTATION TODAY AND TOMORROW"

HOW THE GEARSHIFT WORKS

The transmission makes it possible to change the speed of a car. It also is used to make it go forward or backward. It changes the relationship or ratio between engine speed and wheel speed.

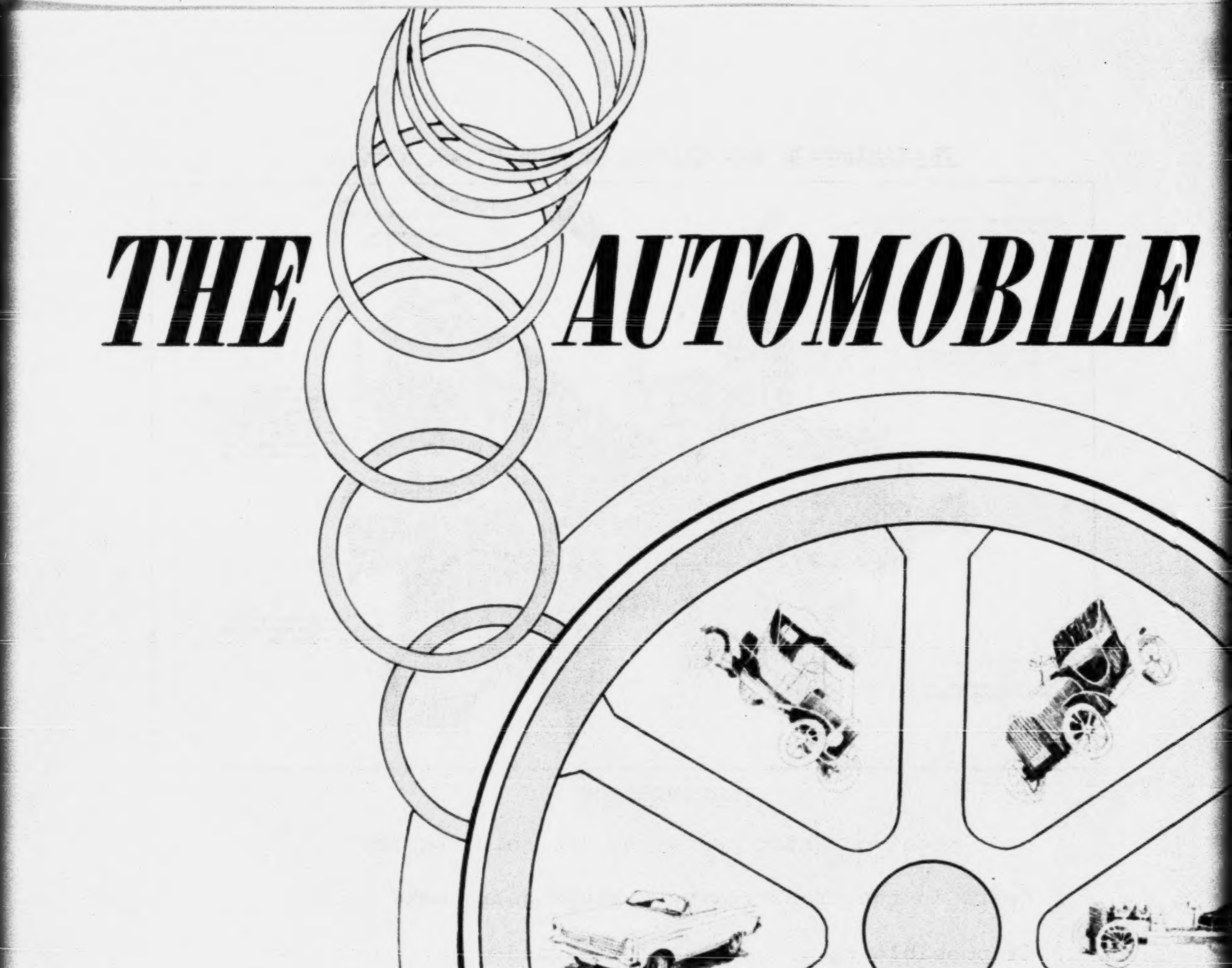
The gearshift in a car is part of the transmission. You probably know that moving the gearshift lever can put a car in low gear or reverse. Often a car will have three different forward speeds.

This figure shows how a typical transmission is arranged. The gears are shown in neutral, first, second, high, and reverse. Look at the diagram for first gear (low speed). The power of the engine goes from the pinion gear to the drive gear on the countershaft. This makes the countershaft and its attached gears turn.

The low gear is fitted into (meshed with) the second sliding gear. The turning of the sliding gear makes the propeller shaft turn with it. The propeller shaft makes the wheels turn.

One of the main parts of the transmission is the sliding gears. The sliding gears may be shifted along

Sample page from "TRANSPORTATION TODAY AND TOMORROW"

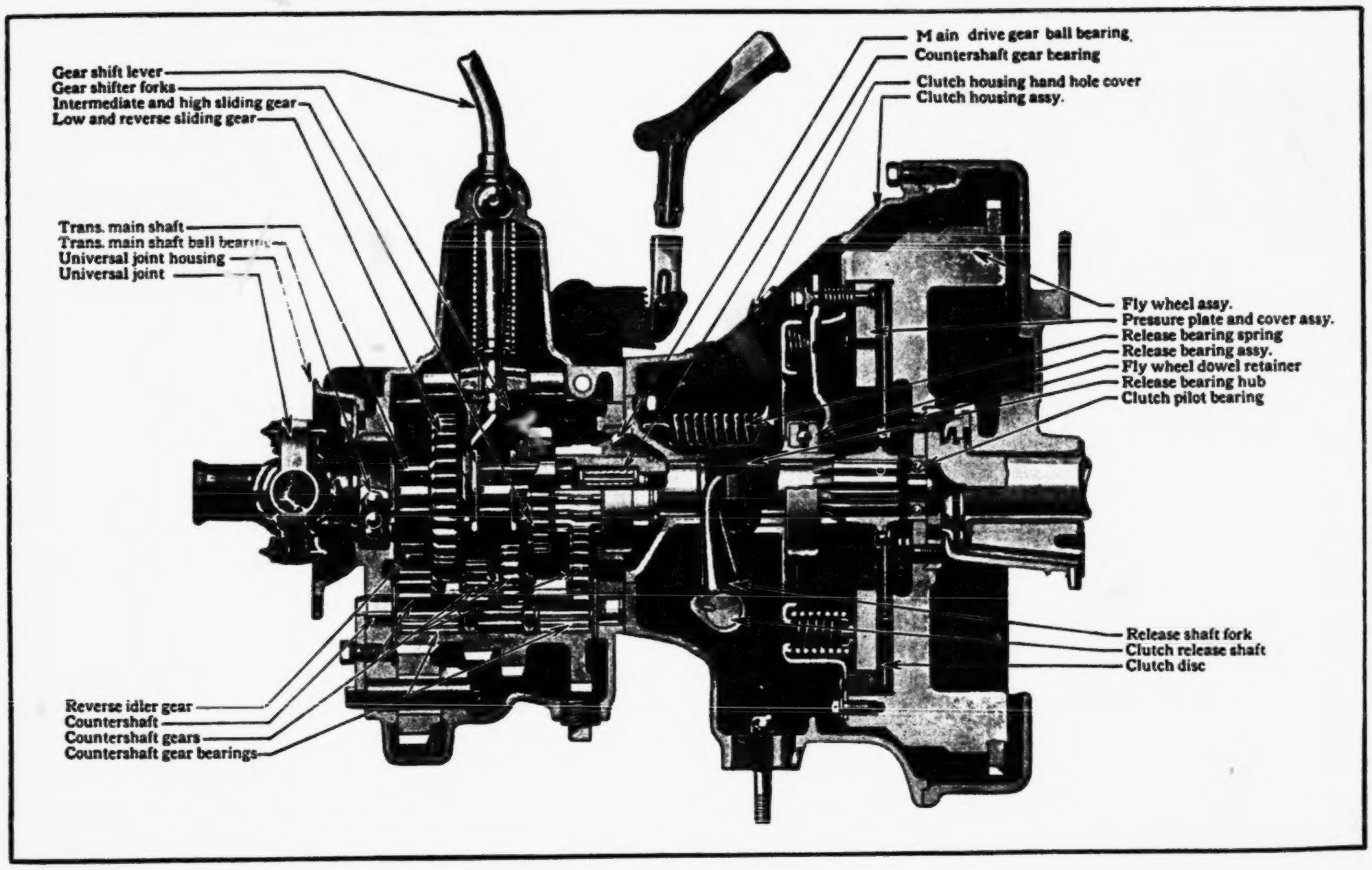


THE AUTOMOBILE

The George Washington University
School of Education
Education Research Project
1166 19th Street, N.W.
Washington, D.C. 20036

Cover of "THE AUTOMOBILE"

TRANSMISSION AND CLUTCH OF THE MODEL A FORD


Gear shift lever
Gear shifter forks
Intermediate and high sliding gear
Low and reverse sliding gear
Trans. main shaft
Trans. main shaft ball bearing
Universal joint housing
Universal joint
Reverse idler gear
Countershaft
Countershaft gears
Countershaft gear bearings
Main drive gear ball bearing
Countershaft gear bearing
Clutch housing hand hole cover
Clutch housing assy.
Fly wheel assy.
Pressure plate and cover assy.
Release bearing spring
Release bearing assy.
Fly wheel dowel retainer
Release bearing hub
Clutch pilot bearing
Release shaft fork
Clutch release shaft
Clutch disc

TRANSMISSION

When you shift gears you are shifting the gears in the transmission. These gears make it possible to go up steep hills and pull heavy loads. They also make it possible to back up.

The clutch connects the engine to the driveshaft. The two plates or discs in the clutch press against each other when the driveshaft is connected.

Sample page from "THE AUTOMOBILE"

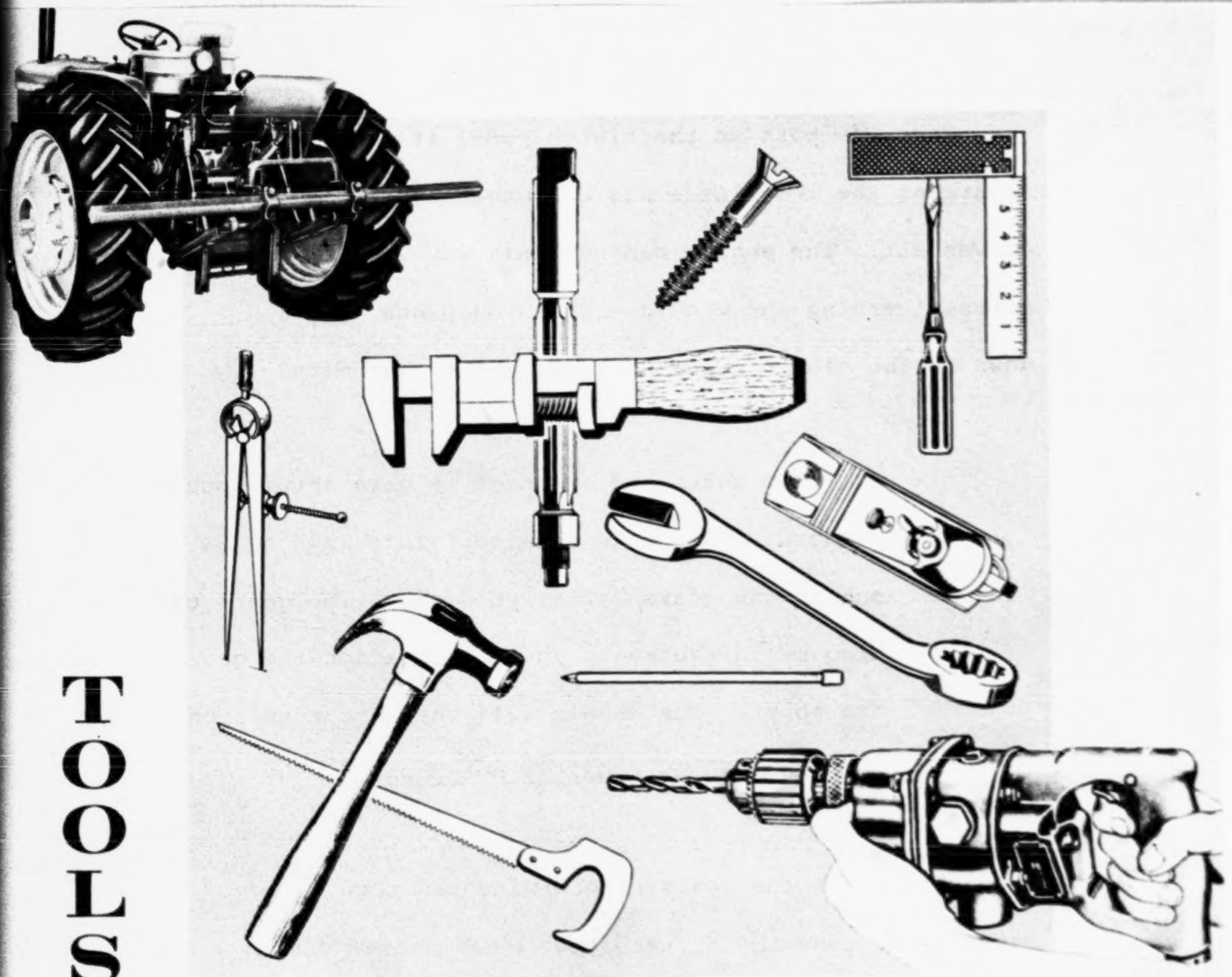
When you push in the clutch pedal it separates the two plates and disconnects the driveshaft. The engine can run this way without turning the wheels. When you press down on the clutch pedal, you can shift the gears.

The gears are arranged to give three speeds forward, and one in reverse. This is done by making the gears different sizes. The gears can also be in neutral. In this position the gears are apart. The wheels will then not turn even when the clutch pedal is not down!

Because of the gears, the engine can turn over faster than the driveshaft. When the engine is turning over at a set speed the driveshaft turns more slowly in low than in high.

The crankshaft will turn several times while the driveshaft turns once. The transmission makes it possible to start in low, shift to second, and then drive in high gear.

Sample page from "THE AUTOMOBILE"



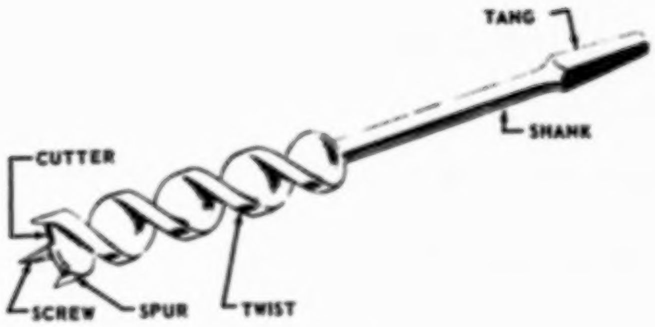
TOOLS

and

BASIC MACHINES

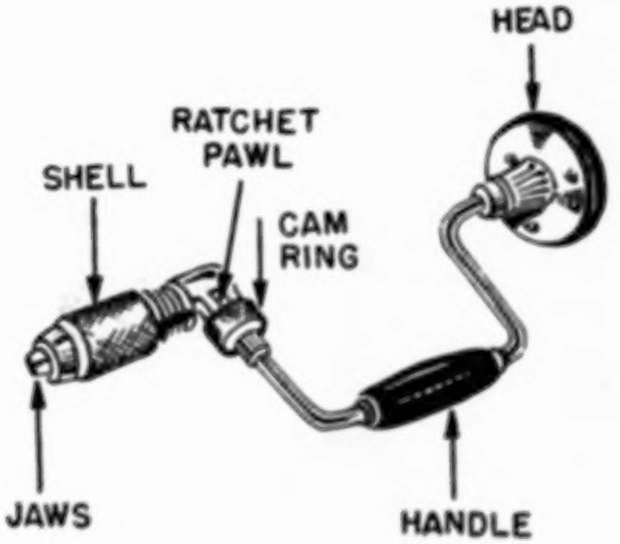
The George Washington University
School of Education
Education Research Project
Washington, D.C. 20036

Cover of "TOOLS AND BASIC MACHINES"


TANG
SHANK
CUTTER
SCREW
SPUR
TWIST

Auger Bit

This is an auger bit. Its parts are labeled. Bits are used for boring holes in wood for screws, hardware, and dowels, and for many other purposes. Auger bits come in many sizes. The regular auger bits are from 7 to 9 inches long. Shorter auger bits, about 3-1/2 inches long, are called dowel bits. Auger bits bore holes up to 1 inch in diameter.


HEAD
RATCHET PAWL
SHELL
CAM RING
JAWS
HANDLE

Bit Brace

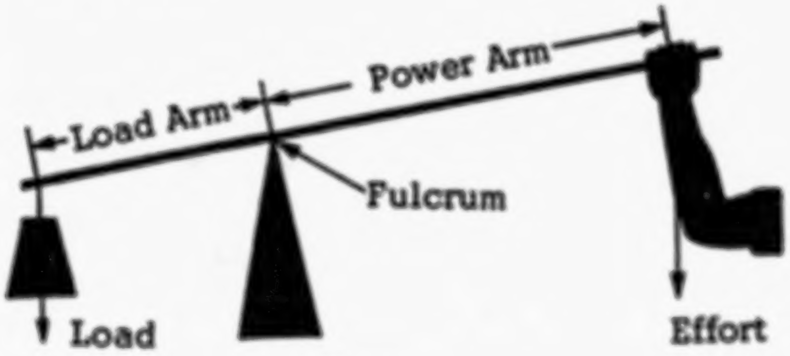
A bit brace is used to hold the auger bit for turning it when boring in wood. The jaws open to grip the bit. The rachet pawl allows the bit to operate in a small space as the handle does not need to be turned all the way around.

Sample page from "TOOLS AND BASIC MACHINES"

THE PRINCIPLE OF THE LEVER

The simplest machine is the lever. Every day, you probably use many types of levers. Bottle openers, pliers, scissors, even some parts of your body, are levers. What is a lever? It is a stiff object, usually a pole, bar, or rod, that can turn about a fixed point, called its fulcrum.

A lever has two arms—the power arm and the load arm. The force applied at the end of the power arm lifts, moves, or balances the load. The power arm is the part of the lever between the fulcrum and the point where force is applied. The load arm is between the fulcrum and the load. The lever can be used to gain a mechanical advantage.

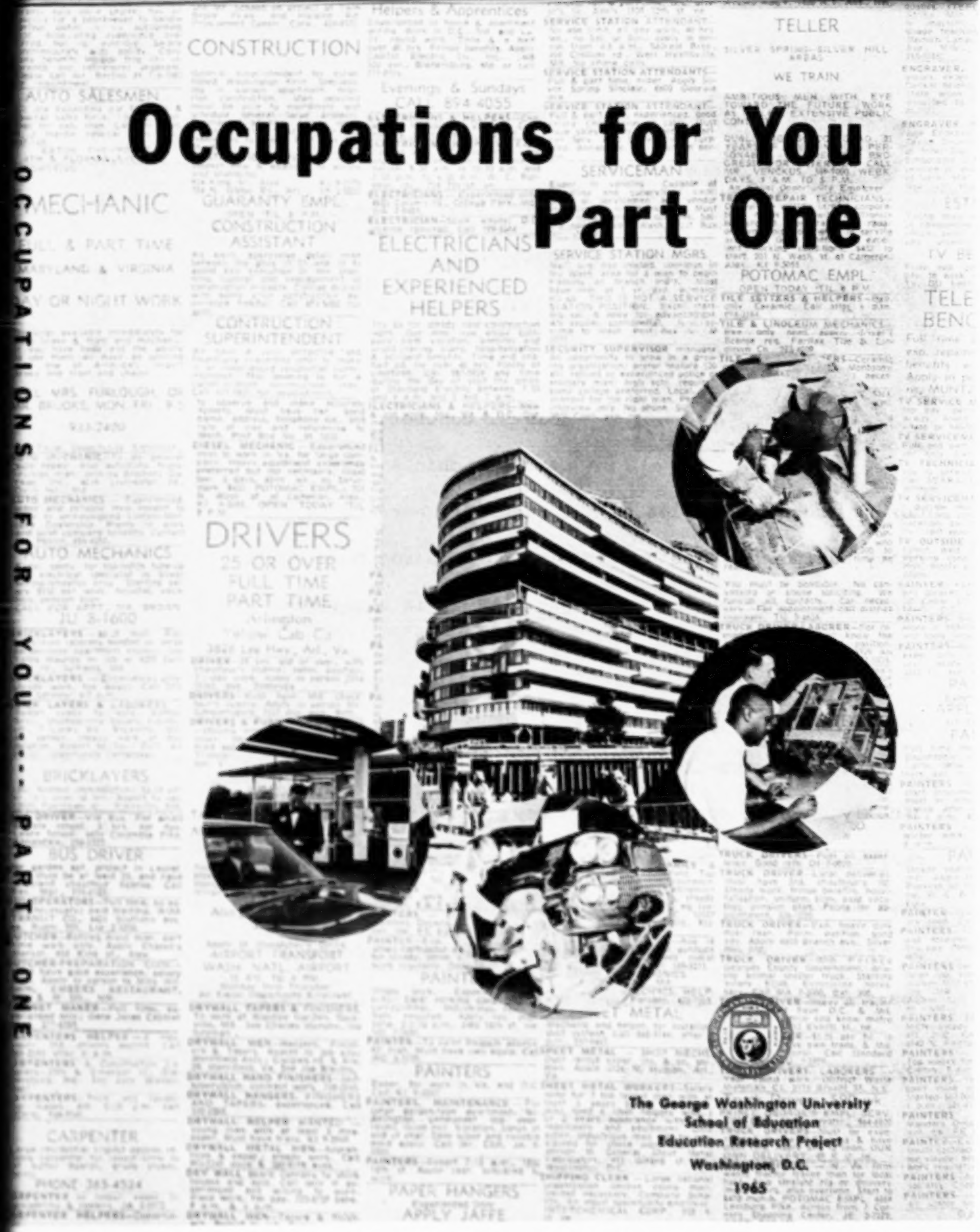


Lever

A lever's mechanical advantage depends on the relationship between the lengths of the power arm and the load arm. A mechanical advantage is obtained when the power arm is longer than the load arm. In this case the applied force will balance a load larger than it is.

The mechanical advantage is less than one when the load arm is longer than the power arm. The applied force must be larger than

Sample page from "TOOLS AND BASIC MACHINES"



OCCUPATIONS FOR YOU .... PART ONE

Occupations for You
Part One

The George Washington University
School of Education
Education Research Project
Washington, D.C.
1965

Cover of "OCCUPATIONS FOR YOU - PART ONE"

HEAVY EQUIPMENT OPERATORS

HEAVY EQUIPMENT OPERATORS
(Construction Machinery Operators)

Weekly Pay:	$180.00
Type of Work:	Skilled; outside
Education:	High school desirable
Training:	Apprenticeship

Power shovels, derricks, hoists, concrete mixers, paving machines and bulldozers are all examples of the machinery handled by heavy equipment operators. This job requires more skill than many construction jobs, but the pay is excellent and the work is usually interesting.

WHAT THEY DO

Heavy equipment operators operate the machinery usually seen at construction sites. They may be in charge of a small machine, such as a cement mixer or a pile driver. They also operate bulldozers, earth movers or graders. Highly skilled heavy equipment operators operate the huge cranes used in building tall buildings.

TRAINING AND REQUIREMENTS

Operating heavy equipment takes a good deal of skill and natural ability. Those who consider this field must

Sample page from "OCCUPATIONS FOR YOU - PART ONE"

DIESEL MECHANICS

Weekly Pay:	$110.00
Type of Work:	Mostly inside; skilled
Education:	High school desirable
Training:	Apprenticeship or on-the-job

The diesel engine industry is one of the newest and fastest growing industries in our country today. The diesel engine is used in all types of vehicles and in many machines. Diesel engines help to build roads, power railroads and buses, do heavy work in industry, and are sometimes used in automobiles.

WHAT THEY DO

There are two kinds of diesel mechanics. One is the mechanic who specializes in maintenance and repair. He does the periodic cleaning, adjusting, and tuneup necessary to keep diesel equipment in good running condition. When an engine is not working properly, the diesel repair mechanic determines what is wrong, and repairs or replaces broken or worn parts. Some diesel repair mechanics also repair brakes or steering systems on diesel vehicles.

Sample page from "OCCUPATIONS FOR YOU - PART ONE"

Appendix B-3

LABORATORY TRAINING EXERCISES

General Considerations

Laboratory training exercises were developed to demonstrate to 9th-grade students those basic aspects of scientific, mechanical, and electrical principles needed in the vocational and technical fields for elementary understanding of underlying phenomena which are not suitable for teaching either by readers or by paper-and-pencil exercises. In each exercise the staff sought simplicity of operation, clarity of presentation, and flexibility for expansion. As with other material developed in this project, the reading level was intended for mature readers who read at about the 6th-grade level. All text for the students was typed double-space with short lines, and line drawings were used to illustrate the text.

Materials Developed

There were four main parts to the laboratory materials:

A kit of materials for each exercise

A pegboard stand on which to mount the materials when called for by the exercise

A teacher's manual, consisting of a lesson plan for each exercise

A student's manual, consisting of text for the student to follow

Laboratory Kits and Pegboard

The kits for each exercise were labeled and packaged separately where possible. As the lesson plans developed it became necessary to send additional equipment or to borrow equipment from other exercises. For that reason a list of materials was include with each of the Student's and Teacher's Exercises, and the students were instructed to check the items. Laboratory kits, except for electronics materials, were supplied in the ratio of three kits to each 50 students. The electronics kits were supplied in the ratio of one kit for each 50 students. It was hoped that this basic ratio of 1 to 17 could be augmented by borrowing from some other class when not in use, as one kit to 7 or 8 students would be a much better ratio. The pegboard was the base on which most of the experiments were to be mounted. Standard commercial pegboard hangers were used where possible.

Teachers were encouraged to devise their own equipment where something additional would aid in teaching the objectives of the exercise. One example of this is in Exercises 1 through 3, where the gears on the gear board are too small for the teeth to be seen easily from the back of the room -- some teachers made larger gears, or used some they already had.

Exercise 1 - SIMPLE GEARS

Objective - To develop an understanding of the operation of a simple gear set.

Materials - A gear mounting board with 3 different kinds of spur gears (40-tooth, 60-tooth, and 80-tooth), thumb screws, nuts, washers, and bushings.

Procedure - First, two spur gears are mounted on the gear board. The direction and speed of each gear is observed. Then additional spur gears are added one at a time until there are six gears in the train. At each step the relationship between the direction of rotation of the gears and their speed of rotation is observed.

Exercise 2 - COMPOUND GEARS

Objective - To develop an understanding of a compound gear set and demonstrate how it differs from a simple gear set.

Materials - Same as for Exercise 1.

Procedure - Compound gears are assembled on the gear board following the diagram in the student's manual. The direction and speed of rotation are observed. Then an additional compound gear is added to the gear train. The difference between simple and compound gears is pointed out.

Exercise 3 - SOLVING GEAR PROBLEMS (Optional Exercise)

Objective - To develop an understanding of how gear trains operate and how they may be used to solve specific problems.

Materials - Same as for Exercise 1.

Procedure - Four specific gear train problems are presented to be solved using the materials of Exercise 1. Several suggested solutions are given to the instructor.

Exercise 4 - FRICTION

Objective - To demonstrate what friction is and how it works.

Materials - A friction block, friction platform, pegboard, pegboard hooks, weights, rubber bands, sandpaper, spring scales, paper clip hooks, and string.

Procedure - Sliding friction, rolling friction, and starting force are demonstrated by observing the amount of weight required to move the friction block over the horizontal friction platform under various conditions. The force necessary to overcome friction of sliding other things is also measured.

Exercise 5 - LEVERS

Objective - To demonstrate how the three classes of levers work.

Materials - Lever arm, weights, pegboard, pegboard hooks, spring scale, rubber bands, and paper clip hooks.

Procedure - First-class, second-class, and third-class levers are demonstrated. Each part of the exercise is illustrated with a drawing or photograph.

Exercise 6 - THE WHEEL AND AXLE

Objective - To demonstrate the mechanical advantage of the wheel and axle.

Materials - Wheel and axle set, pegboard, pegboard hooks, weights, paper clip hooks, and string.

Procedure - The principle of the lever is extended to the wheel and axle by means of balancing a force at the wheel with another at the axle and observing the action. The effect of friction is discussed.

Exercise 7 - BELTS, PULLEYS, AND BEVEL GEARS

Objective - To develop an understanding of the principles of belt and pulley operations, and to understand how bevel gears work.

Materials - Three-step pulleys, mounting bolts and nuts, bevel gear set, pulley rubber bands, and pegboard.

Procedure - Pulleys are explained using both crossed and uncrossed belts. They are then related to gear trains in regard to direction and speed of rotation. A compound pulley arrangement is set up and demonstrated. Bevel gears are demonstrated and the similarity to and difference from spur gears explained.

Exercise 8 - THE INCLINED PLANE

Objective - To demonstrate an understanding of the principle of the inclined plane.

Materials - Friction block and platform, weights, string, toy automobile, spring scales, hooks, pulley, washers, and pegboard.

Procedure - The principal approach is to show the difference in force necessary to move various objects over a low slope (10°) inclined plane and a steeper inclined plane (25°) as compared with a horizontal plane. Both the weight required to move various objects and the spring scale readings are recorded for comparative purposes rather than as a scientific measure of results.

Exercise 9 - THE PULLEY (Block and tackle)

Objective - To demonstrate how the pulley or the block and tackle works.

Materials - Single and double pulleys, weights, string, spring scales, pegboard hooks, and pegboard.

Procedure - All combinations of pulleys from the single fixed pulley to two double pulleys with four strands to the movable block are demonstrated by means of balancing weights and measuring the force required in hoisting weights.

Exercise 10 - DETERMINING WEIGHTS (Optional Exercise)

Objective - To develop an understanding and appreciation of the principle of a balance type scale.

Materials - Lever arm, mounting brackets, weights, small washers, spring scales, toy car, and friction block.

Procedure - A type of lever arm is set up so that it is balanced in the middle. After balancing the lever arm, a one-ounce weight is balanced by the small washers and the approximate weight of each washer determined. Then various objects that were used in previous experiments are weighed by means of the washers and weights. A table for recording observations is used to show the relationships rather than for scientific demonstration.

Exercise 11 - MAGNETISM

Objective - To develop an understanding of the principle of magnetism, and to demonstrate how magnets work.

Materials - An assortment of magnets, iron filings, both magnetic and non-magnetic materials, electromagnet, compass, string, thread, pegboard hooks, batteries.

Procedure - The magnetic materials are sorted from the non-magnetic ones. It is shown that non-magnetic materials allow magnetic lines of force to pass through them. The law of the poles is demonstrated. Then the compass and other magnets are used to locate the poles in some of the oddly shaped magnets.

Exercise 12 - MAKING MAGNETS (Optional Exercise)

Objective - To demonstrate how to make two kinds of magnets.

Materials - Same as for Exercise 11.

Procedure - Magnets are made from various magnetic materials by stroking them with a magnet. Then an electromagnet is developed from wire and the U-shaped bar and its polarity investigated with the compass.

Exercise 13 - SIMPLE CIRCUIT

Objective - To demonstrate how a simple electrical circuit works.

Materials - Wired electrical panel, 110/10-volt transformer, hook-up wires, 10-volt bulbs, and screwdriver.

Procedure - Very rudimentary series circuits are made and demonstrated by connecting the transformer directly to various lights. Practice is given in tracing circuits. The various switches are introduced into the circuit as well as into the rheostat mounted on the electrical panel.

Exercise 14 - SERIES AND PARALLEL CIRCUITS

Objective - To demonstrate what series and parallel circuits are, and to show how they are different.

Materials - Same as for Exercise 13.

Procedure - A simple series circuit, consisting of a switch and two lights, and then a switch and three lights, is set up and the effects noted. Then a parallel circuit is developed first with one light, then with two and three lights, and the effects noted and compared with the series circuit.

Exercise 15 - THREE-WAY SWITCHES

Objective - To demonstrate how the three-way switches work.

Materials - Same as for Exercise 14.

Procedure - Using the materials mounted on the electrical panel, the wiring arrangements required to provide a three-way switch are demonstrated. The corresponding schematic wiring diagram is given.

Exercise 16 - ALTERNATING AND DIRECT CURRENT

Objective - To develop an understanding of the difference between alternating and direct current.

Materials - Small 110/10-volt transformer, wire, compass, dowel, 6-volt battery, and earphones.

Procedure - A wire is coiled to produce an electromagnetic field when connected to a battery, and tested with the compass. Then the same coil is connected to the transformer, with considerably different results when tested with the compass. Then the effect of the two magnetic fields on a simple earphone is observed and explained.

Exercise 17 - SIMPLE AUDIO AMPLIFIER AND RADIO

Objective - To demonstrate how to make a simple audio amplifier and then to connect it into a radio.

Materials - Special kit.

Procedure - The radio receiver is wired up using the wiring diagram and special pegboard in the kit, but the audio stage of the circuit is first wired as an audio amplifier following special instructions. Then the radio section is connected up to operate as a receiver. Care in following instructions and checking to make sure everything is correct before proceeding with the next step are very essential in this exercise.

Exercise 18 - SIMPLE RADIO TRANSMITTER

Objective - To demonstrate how to make a simple radio transmitter.

Materials - Special kit.

Procedure - Again the procedure to follow the wiring diagram for connecting the materials together on the pegboard is demonstrated. Special care must be taken to follow instructions as the transmitter will not work or parts may be damaged if not connected correctly. The transmissions are checked using a portable radio as a receiver.

Appendix B-4

VOCATIONAL EDUCATION TEST BATTERY

General Description

This test battery contains thirteen tests and an interest inventory scale taken from the Project Talent Test Battery. These tests, with their corresponding Project Talent identification, are listed below. The Interest Inventory was adapted from the longer instrument of Project Talent. For details of these modifications see Chapter 3 of this report.

Test Booklet

This test booklet contains the following Project Talent Tests:

Name of Test	No. of Items	Time (min.)	Project Talent Identification
Abstract Reasoning	15	11	R-290
Mechanical Reasoning	20	11	R-270
Arithmetic Reasoning	16	12	R-311
Visualization in Two Dimensions	24	4	R-281
Visualization in Three Dimensions	16	9	R-282
Reading Comprehension	48	30	R-250
Information Test:		45	R-190*
Vocabulary Scale	21		R-102
Mathematics Scale	23		R-106
Physical Sciences Scale	18		R-107
Biological Sciences Scale	11		R-108
Aeronautics and Space Scale	10		R-110
Electricity and Electronics Scale	20		R-111
Mechanics Scale	19		R-112
Interest Inventory	150	15	R-700**

*Modified form, keeping scales intact

**The following scales were used from the Project Talent Interest Inventory: Physical Sciences (16), Biological Sciences (8), Literary-Linguistic (16), Sports (8), Hunting and Fishing (3), Business-Management (14), Sales (6), Computation (10), Office Work (7), Mechanical-Technical (15), Skilled Trades (18), Farming (7), Labor (10), and Miscellaneous (12).

A brief description of each of these tests follows (Project Talent, 1960):

Abstract Reasoning (R-290) -- This is a non-verbal test to measure one kind of abstract reasoning ability—the ability to determine a logical relationship or progression among the elements of a complex pattern, and to apply this relationship to identify an element that belongs in a specified position in the pattern. Some youngsters who have had little schooling, or who have had serious cultural or environmental handicaps which result in low scores in vocabulary and reading comprehension, may make a high score on the abstract reasoning test, indicating greater potential for academic work than has been developed. Among typical students, who have had a natural environmental background, the abstract reasoning score should be considered just another element in the general domain of intellectual ability.

Mechanical Reasoning (R-270) -- The purpose of this test is to measure the ability to visualize the effects of the operation of every-day physical forces (such as gravitation) and basic kinds of mechanisms (for instance gears, pulleys, wheels, springs, levers). A kind of reasoning which is related to mechanical aptitude is involved. Although all of the items can be answered without specific formal training in physics and without experience in woodworking or other crafts, or in working with motors, past training and experience must nevertheless be borne in mind in interpreting the results.

Arithmetic Reasoning (R-311) -- This test is designed to measure the ability to do the kind of reasoning required to solve arithmetic problems. Computation, except at the very simplest level, is excluded from the test.

Visualization in Two Dimensions (R-281) -- This test measures the ability to visualize how diagrams would look after being turned around on a flat surface, in contrast with the way they would look after being turned over.

Visualization in Three Dimensions (R-282) -- This test measures the ability to visualize how a figure would look after manipulation in three-dimensional space (more specifically, how a two-dimensional figure would look after it had been folded to make a three-dimensional figure).

Reading Comprehension (R-250) -- The purpose of this test is to measure the ability to comprehend written materials. The ability measured is the ability to read with comprehension, rather than mere ability to mouth or recognize the printed word without understanding the fact, idea, or concept that the writer is attempting to convey. The test includes passages on a wide range of topics. The student reads the passage and then answers a number of questions about it, referring back to the passage as often as he likes. None of the items is answerable without reading the passage. The ability measured by this test is sometimes called "academic intelligence" and is a good predictor of school success in an academic or liberal arts curriculum. In the unusual situation where a student scores low on the reading comprehension test but obtained good scores on other types of intellectual tests, he may have a specific reading disability that can be corrected by special remedial training.

Vocabulary Scale (R-102) -- This score gives some indication of the relative size of the student's general vocabulary. This is often used as an index of academic aptitude, and the ability measured by this test is sometimes called "verbal intelligence." The relatively small number of items makes this measure a less stable predictor than some of the others, such as Information Test Total.

Mathematics Scale (R-106) -- These items are concerned with definitions, the vocabulary of mathematics, mathematical notation, other kinds of factual information, and the understanding of mathematical concepts. None of the items requires computation or reasoning or calls for solving a problem, since these abilities are covered by other tests in the battery (the Arithmetic Computation Test and the Mathematics Test).

Physical Sciences Scale (R-107) -- This scale includes items about chemistry, physics, astronomy, and other physical sciences. Many of the items cover information that might readily be acquired in other ways than through formal instruction.

Biological Sciences Scale (R-108) -- This scale includes items about botany, zoology, and microbiology. A few items about nature lore are included, though most of the items are concerned with more formal aspects of biological science.

Aeronautics and Space Scale (R-110) -- These items are on such topics as flying technique, navigation, jet planes, and space exploration. Much of the information that the student has in this area is likely to have been acquired out of school. Separate percentile norms are provided for boys and girls.

Electricity and Electronics Scale (R-111) -- These items stress information that is acquirable through direct experience in the construction and maintenance of electrical and electronic equipment. Students who have worked on radios, hi-fi sets, or other electronic equipment, or on mechanisms with electric motors, should get good scores. Since the range of content covered is fairly broad, it seems likely that the average high school student will be able to answer many of the questions if he is at all interested in the area. Separate percentile norms are provided for boys and girls.

Mechanics Scale (R-112) -- These items tap a wide range of information. Many of them are concerned with automobiles; others are concerned with other common machines and tools with which boys who are interested in mechanical activities are likely to be familiar. The emphasis is on information that is likely to be acquired through direct experience with tools, engines, and motors. The scores should also be influenced by the amount of experience and training in mechanics the student has had. Separate percentile norms are provided for boys and girls.

Test Administrator's Manual

The instructions given for administering the tests listed above were adapted from the Project Talent "Teacher's Guide", the principal difference being that the testing was arranged for four class periods as follows:

First Period

- Abstract Reasoning
- Mechanical Reasoning
- Arithmetic Reasoning

Second Period

- Visualization in Two Dimensions
- Visualization in Three Dimensions
- Reading Comprehension

Third Period

- Information Test

Fourth Period

- Interest Inventory
- Student Information Blank

As with the Project Talent instructions, examples are given for the teacher or administrator to use. The Answer Sheets are different from those in the Project Talent Battery.

Also contained in the Administrator's Manual are norms taken from the Project Talent report, "Studies of a Complete Age Group--Age 15". These are tables for each test showing percentile rank corresponding to each raw score for boys and girls separately and combined.

Answer Sheets A, B, C, and D

These answer sheets are designed for machine scoring, and are in the same general format as the Project Talent answer sheets, except that the Information Test and the Interest Inventory were modified to correspond to the shortened instruments.

These answer sheets were to be used by the students in taking tests as follows:

Answer Sheet A

Abstract Reasoning
Mechanical Reasoning
Arithmetic Reasoning

Answer Sheet B

Visualization in Two Dimensions
Visualization in Three Dimensions
Reading Comprehension

Answer Sheet C

Information Test

Answer Sheet D

Interest Inventory

Student Information Blank

The Student Information Blank is similar in many respects to the Student Information Blank used in Project Talent. Many of the questions were taken verbatim from that instrument. Several others were added which would apply specifically to the vocational orientation of the sample with whom the instrument was to be used. For this purpose the following questions were added:

10. How many years have you lived on a farm?
11. How many years ago did you live on a farm?

14. Have you ever adjusted or helped to adjust the carburetor of an automobile?
15. Have you ever repaired a bicycle?
16. Have you ever made repairs to a motorcycle, or helped someone else make them?
17. Have you ever used a power lawn mower?
18. Have you ever operated a tractor?
19. Have you ever attended an automobile race (including drag race)?

There was a second part added to the Student Information Blank which was also not a part of the Project Talent instrument. This part asked the students to respond with "Very well", "Fairly well", "Not very well", or "Not at all" to the question "How well would you like to take the following vocational training programs? PLEASE ANSWER EACH ONE." The courses asked about are:

1. Air Conditioning and Refrigeration
2. Appliance Repair
3. Auto Mechanic
4. Auto Body and Fender Repair
5. Airplane Mechanic
6. Baking
7. Bricklaying
8. Building Custodial
9. Carpentry
10. Commercial Art
11. Cooking
12. Diesel Mechanic
13. Drafting
14. Dry Cleaning
15. Electrical Trades
16. Electronics Technician
17. Furniture, Upholstery, and Repair
18. Hospital Aide
19. Heavy Equipment Operator
20. Heavy Equipment Repair
21. Landscaping
22. Laundry
23. Machine Shop
24. Meat Cutting
25. Office Occupations
26. Painting
27. Photography
28. Plant Maintenance
29. Plumbing
30. Printing
31. Radio and TV Service
32. Retailing
33. Sanitation and Utilities
34. Service Station Attendant
35. Sheet Metal Working
36. Small Gas Engine Repair
37. Tailoring
38. Welding

Appendix C

SPECIAL STUDIES

As part of the process of determining the types and levels of individuals for whom the materials were appropriate, several groups were authorized to use the materials on an experimental basis. In two such cases the Project Talent tests were used for a pre-test and post-test evaluation. The results of these two studies are reported below.

A. National Council for Children and Youth (N.C.C.Y.)

The objective of the N.C.C.Y. program was to train referred volunteers (from the recruiting offices) who had failed the Armed Forces Qualification Test (AFQT). These volunteers were trained with the objective of qualifying them to achieve a passing score on the AFQT, the GATB, or a vocational school entrance examination.

The ages of the young men in this program ranged from 17 years to 25 years.

One group of volunteers was trained with a curriculum that was parallel to the type of testing material contained in the AFQT and the GATB. It included:

1. Mathematics
2. Vocabulary
3. Tool identification and block patterns
4. Curriculum developed by the Education Research Project, The George Washington University

    a. Abstract Reasoning
    b. Spatial Relations
    c. Laboratory Exercises on basic mechanical principles

The number of students in the class fluctuated between 15 and 30. The total number of participating students, including the dropouts, totaled 37. The majority of these students had failed all parts of the AFQT.

A project staff member, as an unpaid volunteer, conducted two 45-minute classes each week over a ten-week period. The first two classes were used to administer the pre-test. Only those parts of the Vocational Education Test Battery were given which related to abstract reasoning, mechanical reasoning, and spatial relations, and parts of the general information test.

The students responded best to an informal and personal approach, and the following comments seem worthy of noting: After two classes on abstract reasoning, one student approached the instructor and said, "Man, after you explain what's goin' on, this jazz is easy." Another said, "You know, after I get the idea, I could do these things all day." Throughout the training period the students showed a marked increase in interest about the material. Five of them requested special classes in order, not to catch up with the class, but to further their knowledge of the material, especially the mechanical and abstract reasoning.

Despite the enthusiasm of the class, the students were still very slow in fully grasping many of the concepts of the material. Only by repetition was any concept finally absorbed by the students. Throughout the program it was necessary to find means of relating the material to their own personal objectives. Once the students saw this relationship they became willing, enthusiastic students.

The series of readers were distributed to the students at the beginning of the program. They were most interested in the Occupations for You--Part One and The Automobile.

Table C-1 shows the results of the pre-test and post-test. Substantial gains were made on some of the tests. While it is difficult to interpret studies based on such small samples, the study indicated that the materials seem to be appropriate for this type of population and caused appreciable gains in test performance with relatively small amounts of training.

B. Project Challenge (N.C.C.Y.)

Project Challenge was begun in 1966 at the Lorton Youth Center, an institution for youthful offenders of the District of Columbia located at Lorton, Virginia, 22 miles south of Washington.

Occupational training areas include automotive repair and servicing, food service, building maintenance, clerical and sales work, barbering, and interior and exterior painting. Local firms are supporting the project with gifts of equipment and assistance in both training and placement. Supportive services include individual, group, and family counseling and job development efforts that resulted in 71 jobs in the first 6 months of the program.

TABLE C-1

Comparison of Pre-Test and Post-Test Raw Scores and Percentiles for Students Trained with Vocational Talent Curriculum Materials in N.C.C.Y.[1] -- January to March 1966

		Pre-Test		Post-Test		Difference	
Subject	N	Raw Score	%ile[2]	Raw Score	%ile[2]	Raw Score	%ile[2]
Abstract Reasoning	15	5.3	17	8.7	48	+3.4	+31
Mechanical Reasoning	15	4.1	4	8.1	22	+4.0	+18
Visualization in Two Dimensions	14	8.1	21	9.5	27	+1.4	+ 6
Visualization in Three Dimensions	17	5.6	21	6.6	31	+1.0	+10
Vocabulary Information	8	4.8	7	4.2	6	-0.6	- 1
Mechanics Information	8	6.4	12	6.1	11	+0.3	- 1
Electricity & Electronics Information	8	4.4	17	6.2	36	+1.8	+19

Notes: [1] N.C.C.Y. - National Council for Children and Youth. Volunteer training school for military service enlistment rejectees on the Armed Forces Qualification Test (AFQT).

[2] Percentile ranks obtained from the national 15-year-old norms for these tests. Project Talent monograph (1960): "Studies of a Complete Age Group - Age 15."

Materials designed to teach the basic vocational talents of abstract reasoning, mechanical reasoning, and spatial visualization were supplied by the Education Research Project of The George Washington University for use at Lorton in a training program sponsored by the National Council for Children and Youth (N.C.C.Y.)

The _Project Challenge_ trainees received an average of 15 hours of instruction per student with the special materials. The vocational education curriculum, designed for 30 hours of instruction, was condensed so that the trainees would receive maximum exposure to the more important areas.

The trainees received instruction in all areas of the _Vocational Talent Exercise_ booklets, but abstract reasoning, spatial visualization, and mechanical text and illustration were stressed. The lever, the gears and belts, the wedge, and the pulley were the only laboratory exercises presented, because of the time schedule. However, several of the advanced students became interested in some of the electrical lab exercises and these students were given special classes by the _Project Challenge_ instructors after the regular class hours.

All of the readers were distributed to all of the trainees. These books were not used in the classes but there was an enthusiastic response to _Occupations for You--Part One_ and _Tools and Basic Machines_.

The amount of learning which took place was measured by pre-test and post-test. The test battery was the same as that used by the Education Research project in measuring change in learning by 8th-grade and 9th-grade boys and girls on these same materials.

Table C-2 shows how the gains of the Youth Center group compare with gains of the experimental schools in 1965-1966. As can be seen, the basic pattern of gains is very similar to the amount of gain obtained in the full school year in the public school tryout. The Lorton group gained from 1.5 years in Mechanical Information to 3.6 years in Two-Dimension Visualization. The heavy gains were in these areas and in nonverbal Abstract Reasoning (3.3 years), Mechanical Reasoning (1.9 years), and Three-Dimension Visualization (1.5 years). On other tests the gains were less than one year.

It seems remarkable that this group showed such large gains in such a short period of training with individuals who had past records of poor school motivation and performance.

The public school groups had 30 hours of training during a full school year and the 9th- and 10th-grade groups had 60 hours of such training during a full school year. The Lorton group with only 15

TABLE C-2

Comparison of Gains of Males in Project Challenge at Lorton, Virginia, with Those in Present Study and Project Talent

	Raw Score Gain					Number of Years Gained			
	$(M_2 - M_1)$					$(M_2 - M_1 / PT)$			
	Lorton N=56	Gr.8 Boys N=567	Gr.9 Boys N=582	Gr.10 Boys N=54	Yearly Gain PT Boys	Lorton	Gr.8 Boys	Gr.9 Boys	Gr.10 Boys
1. Abstract Reas.	1.554	1.351	1.699	1.000	.47	3.306	2.87	3.615	2.128
2. Mechanical Reas.	1.536	1.520	1.610	1.185	.80	1.920	1.90	2.012	1.481
3. Arithmetic Reas.	0.571	.593	.850	.204	.72	0.793	.82	1.181	.283
4. Vis 2D	3.590	4.917	5.178	5.834	1.01	3.554	4.87	5.127	5.776
5. Vis 3D	0.911	1.258	1.756	2.018	.62	1.469	2.03	2.832	3.255
6. Reading Comp.	1.839	1.876	2.787	2.611	2.10	0.876	.89	1.327	1.243
Information Tests									
7. Vocabulary	0.697	.656	.993	2.797	.87	0.801	.75	1.141	3.215
8. Mathematics	0.643	.777	1.331	.945	1.44	0.447	.54	.924	.656
9. Physical Sci.	0.214	.391	1.251	1.426	.53	0.404	.74	2.360	2.691
10. Biological Sci.	0.179	.374	.292	1.315	.40	0.407	.94	.730	3.288
11. Aero. & Space	0.071	.284	.571	1.648	.44	0.001	.65	1.298	3.745
12. Elect'y & Elect.	0.482	.710	1.263	.963	.90	0.536	.79	1.403	1.070
13. Mechanics	1.179	.601	1.462	2.852	.81	1.456	.74	1.805	3.521

hours gained as much as the public school students did. The Lorton demonstration indicated that the materials can be used quite effectively by individuals without academic training in the field of education. The results of the Lorton demonstration indicate that the materials should have widespread use with programs for individuals such as the ones that trained there. This might do much to increase their ability to be trained for good jobs after they have been released.

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